701 OSCILLOSCOPE

Instruction Manual

Serial No. _____

FAIRCHILD

INSTRUMENTATION

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

TYPE

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50 SOMERSET PLACE, CLIFTON, N. J. 07015

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SECTION 1
TECHNICAL SUMMARY

1-1. INTRODUCTION

The Type 701 Transistorized Oscilloscope is a precise measuring instrument designed to be used for almost any general application. Simplicity of operating controls assures reliable performance in laboratory, factory and field applications. Accurate measurements can be made of electrical waveforms from dc to 500 Kc at calibrated sweep rates of 5 μsec/cm to 200 msec/cm.

1-2. FEATURES

- Constructed for universal bench or rack use. A tilt foot assembly for bench use is supplied with each unit
- General purpose oscilloscope that is *easy-to-use*, rugged and reliable
- Frequency response and gain of the Y amplifier extends from dc to 3 db down at 500 Kc at a sensitivity of 10 millivolts/cm
- Frequency response and gain of the X amplifier extends from dc to 3 db down at 350 Kc at a sensitivity of 100 millivolts/cm
- Calibration voltage is provided
- Calibrated linear sweep rates from 5 microseconds/cm to 200 milliseconds/cm in fifteen steps of 1, 2, and 5 sequence
- Uncalibrated linear sweep, continuously variable in rate from 5 microseconds/cm to 1 second/cm. Longest sweep time is 10 seconds full scale
- Driven, automatic, or single (armed) sweep operation with automatic forward trace brightening
- A 10 times expander extends the fastest sweep to 0.5 μsec/cm and features continuous control from X1 to X10 for precise viewing of any section of the magnified sweep
- The new high resolution cathode-ray tube is driven by transistorized amplifiers and can be supplied with an illuminated *no-parallax* graticule
- Silicon transistors and fully regulated electronic power supplies assure maximum drift stability and long-term reliability

1-3. LIST OF RECOMMENDED ACCESSORIES

Type or Part Number	Description
	ATTENUATOR PROBES
	(10:1 Passive Probe; terminated in BNC type connector)
4290	10 megohms, 10 pf input; 4-foot cable
4298	10 megohms, 14 pf input; 6-foot cable
4299	10 megohms, 12 pf input; 6-foot cable
	COLOR FILTERS
4800 5861	Amber for P7 screen
4800 5862	Blue for P11 or P7 screen
4800 5863	Green for P1, P2 & P31 screen
4800 6101	Neutral filter, circularly polarized
	RECORDING CAMERAS
450A/453A	Oscilloscope record camera with suitable accessories

TYPE 4002B KIT

This kit includes the components listed as follows:

Qty	Part Number	Description
2	0903 6940	Type 7080 Adapter Connector; BNC-type-to-binding post adapter; UG-1090/U
1	8700 1224	Type 4002A Electrical Test Fixture (620K-ohm resistor)
2	9800 0629	Type 2592-B Shielded Terminal Adapter; this is a binding-post-to-BNC-type adapter
1	9800 1941	Type 276-C Viewing Hood
1	9800 2172	Type 4290 10:1 Attenuator Probe terminated in BNC type connector; 10M ohms, 10 pf input
1	0905 8940	Type 7084 Adapter Connector; UG-636/U C male to BNC female
1	9800 2112	Type 4285 50-ohm, 2-watt termination
1	5028 8581	Type 7083 BNC to Alligator Clip Jumper Cable

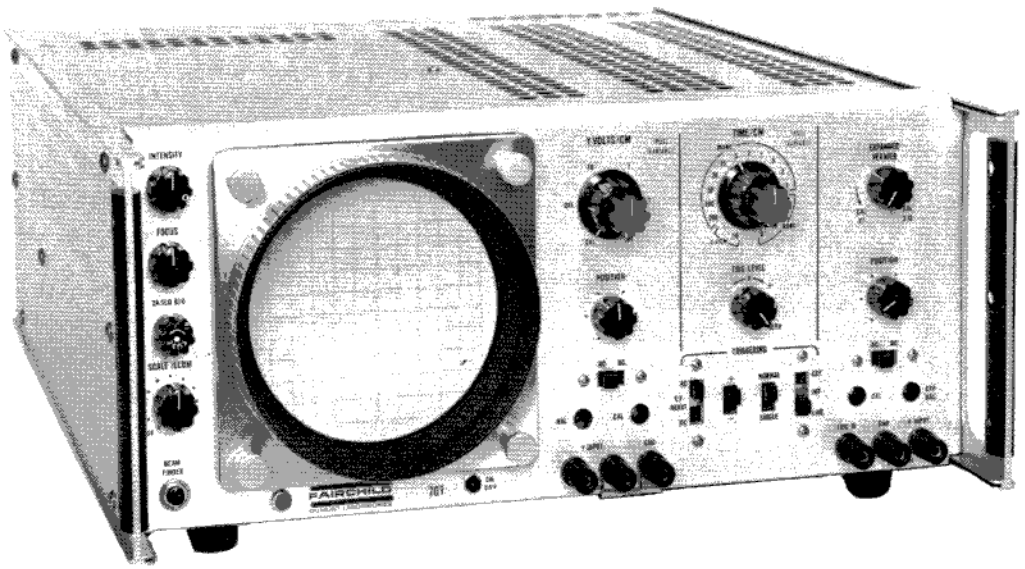
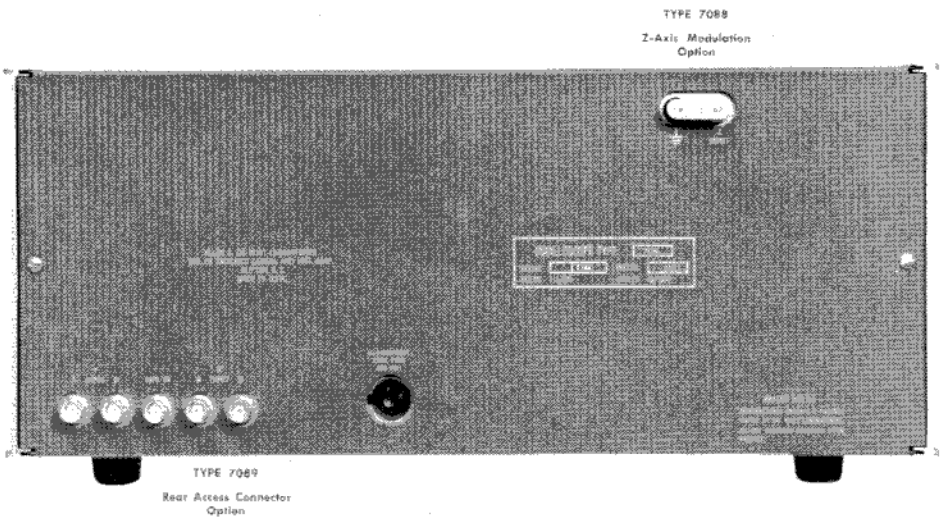


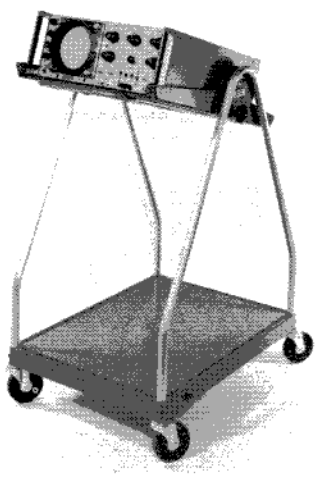
Figure 1-1. Type 701 Oscilloscope

Type or Part Number	Description
	MISCELLANEOUS
276-C	Viewing Hood
2592-B	Shielded adapter connector; scope binding post to BNC
4285	50-ohm, 2-watt termination
7012	Input Capacitance Standardizer
7013	Tool Kit
7030	Scope Traveler
7082	42-inch coaxial jumper cable with BNC connectors at either end
7083	42-inch coaxial jumper cable with BNC connector at one end and alligator clip at the other end
7084	Adapter connector; UG-636/U C male to BNC female
7085	Slides for rack mounting
7086	Rack-mounting ears
7088	Z-axis modulation option
7089	Rear access connector option

1-4. TECHNICAL SUMMARY TABLE (given on next page)



Types 7088 and 7089 Optional Accessory Kits (Installed)



Type 7030 Scope Traveler (Accessory)

SPECIFICATIONS

VERTICAL-DEFLECTION SYSTEM

Bandwidth

Direct Coupled: DC to 500 Kc; down 3 db at 500 Kc

Capacitively Coupled: Low frequency cutoff is 2 cycles

Rise Time: 0.8 microsecond with less than 2% overshoot or pre-swing

Sensitivity

10 mV/cm to 10V/cm in 5 decade steps; accurate to within ±3%. An OFF position is included for dc balancing

The PULL VARIABLE control permits 10 to 1 continuous sensitivity adjustments between the attenuator steps and extends the 10V/cm range to 100V/cm. The VARIABLE knob is provided with a push-pull switch to facilitate calibration check; the pulled knob indicates uncalibrated vernier gain setting

Input Impedance

1 megohm, constant within ±3% at all attenuator settings for single-ended operation; nominally 40 pf; constant within ±5% from range to range. Coupling may be direct or through capacitor of 0.1 μf 600-volt rating to amplifier

Input Connectors

Combination binding posts spaced on ¾-inch centers to accommodate Type 2592-B shielded terminal adapter. Two binding post connectors are provided for differential input and a ground binding post and connector strap are provided for single-ended amplifier operation

Differential Input

Available only on the 0.01 attenuator setting. Input impedance is 2 megohms shunted by less than 31 pf on 10 mV/cm range. Sensitivity may be decreased to 100 mV/cm with vernier control

Common Mode Rejection

Nominally 120:1, always better than 100:1 (40 db). Measured at 60 cycles and not controlled at higher frequencies. Common mode signal must not exceed 6 volts peak-to-peak ac or ±3 volts dc

Phase Shift

At calibrated gain, the phase shift between the orthogonal systems is adjustable to ±1° at any point from dc to 100 Kc. When adjusted to 0° at 50 Kc, the phase shift differential is ±3° from dc to 100 Kc

HORIZONTAL-DEFLECTION SYSTEM

Bandwidth

Direct Coupled: DC to 350 Kc; down 3 db at 350 Kc

Capacitively Coupled: Low frequency cutoff is 2 cycles

Sensitivity

Three calibrated steps of 0.1V/cm, 1V/cm and 10V/cm; ±5%. The EXPANDER VERNIER control permits continuous adjustments from 0.1V/cm to 10V/cm

Input Impedance

1 megohm shunted by 50 pf

TRIGGERING SYSTEM

Internal Trigger

Sweep will trigger from ½ centimeter of vertical signal on normal and single sweep position. Less than 4 millimeters are required in the auto triggering position. A choice of trigger polarity (slope) is available

Line Trigger

Line frequency triggering can be selected in either polarity and the triggering point may be shifted with the TRIG LEVEL control

External Trigger

0.5 volt peak-to-peak from dc to approximately 300 Kc will trigger the sweep. 0.75 volt peak-to-peak will synchronize the sweep to 500 Kc. Approximately 0.4 volt peak-to-peak is required for auto triggering operation. Trigger leveling, polarity selection and ac or dc coupling are included

AC Coupling

High-pass filter with low-frequency cutoff of 80 cycles

DC Coupling

Direct coupling is provided to optimize trigger sensitivity when very slow waveforms are applied; to maintain the initial reference position of the trace with respect to the CRT scale at a given trigger level setting; and to avoid trigger point variations due to random repetition rate trigger signals

LF Reject

Differentiated trigger input; high-pass filter is provided to reject hum and low-frequency amplitude modulation; low-frequency cutoff nominally 15 Kc. Signals should rise or fall in less than 100 μsec to pass the LF reject filter

Trigger Slope

Selection of positive or negative slopes on Internal, Line, or External triggering is available

Trigger Level

A range of ±10 volts for External Trigger Input or 1½ times full scale on internal triggering

Automatic Triggering

Auto triggering is available on Internal, External, and Line trigger sources. Auto triggering simplifies synchronization and provides a continuous base line at a frequency of approximately 50 cycles

TIME BASE SYSTEM

Sweep Range

Calibrated linear sweep rates from 5 μsec/cm to 200 ms/cm in 15 steps of 1, 2, and 5 sequence

The PULL VARIABLE control provides a continuous uncalibrated range of sweep rates between ranges and extends the 200 ms/cm range to 1 sec/cm (10 seconds full scale)

Sweep Accuracy

Normally within ±2%; always within ±3% (averaged over the centered 8 cm portion of the CRT screen)

Sweep Expansion

The calibrated sweep may be expanded about center of screen 10 times. Extends fastest sweep rate to 0.5 μs/cm within 10%

Expanded Sweep Positioning

Sufficient to position any full scale portion of the expanded trace on the screen

Single Sweep

An unblanked single-sweep mode is available with manual reset via a front-panel switch

CATHODE-RAY TUBE DATA

Type

F7010-O-P31, tight tolerance, high resolution cathode-ray tube is normally supplied; 2700 volts accelerating potential

Optional Phosphors

P7 phosphor for long persistence low frequency or transient observation; P11 for photographic use; and P2 phosphor for combination visual and photographic use are also available

Bezel

Light-tight bezel provides firm mount for an oscilloscope camera and permits ready interchange of filters and scales

Graticule

Engraved edge-lit graticule having 10 cm by 10 cm graduations and appropriate color filter over face of tube. Scale illumination control varies illumination level from zero to intensity adequate for photographic recording. CRT internal no-parallax graticule is optionally available

Beam Finder

A spring-loaded push-button switch is provided to facilitate location of beam when it is positioned off screen

Z Axis (Type 7088 Option)

Negative pulse to grid of CRT blanks trace. 25 volts are required into an impedance of approximately 600K ohms coupled via 3300 pf capacitor to dim trace

VOLTAGE CALIBRATOR

Availability

0.5V peak-to-peak calibrator signal available at pin jack on front panel; fast rise and fall time permits adjustment of attenuator probes. Calibrator signal of 50 mv is applied to the input of Y amplifier to aid in standardizing gain

Accuracy

Nominally ±1%, always within ±3%

Frequency

Locked to power-line frequency. This signal may be used to calibrate the time axis wherever the power-line frequency is a controlled standard

POWER REQUIREMENTS

Line Voltage

From 105 to 125 volts or from 210 to 250 volts at 60-cycle line

Line Frequency

Operation from 48 through 450 cycles; line voltage excursion is reduced at extremes of frequency range and where power line distortion exceeds 5%

Power

145 watts average; 185-volt amperes at 115-volt, 60-cycle line

DC Power Supplies

All supplies including the critical tube heaters are electronically regulated

MECHANICAL DIMENSIONS

Note: This oscilloscope is constructed for universal bench or rack use

	Bench		**Rack*		
Height	7 5/8"	(19.3 cm)	6 3/32"	(17.7 cm)	
Width	16 3/4"	(42.5 cm)	19"	(48.2 cm)	
Depth	19 1/2"	(49.5 cm)	17 1/2" 16 1/2"	(44.5 cm) (42 cm)	Normal Mounting Bracket Reversed
Weight	29.5 lbs	(13.4 kg)	29.5 lbs	(13.4 kg)	
Shipping Weight	40 lbs	(18.1 kg)	40 lbs	(18.1 kg)	

* A minimum of 2" clearance must be maintained for the rack-mounted model to assure adequate cooling. Do not subject the unit to the hot exhaust air of adjacent equipment.

SECTION 2
OPERATING INSTRUCTIONS

2-1. FIRST TIME OPERATION (Figures 2-1 to 2-5)

To place the instrument in operation, plug the power cord into the proper grounded power source and turn INTENSITY control counterclockwise. Rotate the SCALE ILLUM control clockwise to apply power. Allow approximately 15 minutes for the instrument to warm up. In the instructions which follow, the words in capital letters within the text indicate front-panel controls, connectors, or settings.

Numerous accessory components are available to extend the usefulness of these oscilloscopes. See Section 1 for a complete listing.

The following illustrations are designed to aid the operator in becoming familiar with the oscilloscope.

Figure 2-1. Front-panel Facilities, CRT System
Figure 2-2. Front-panel Facilities, Vertical Deflection System
Figure 2-3. Front-panel Facilities, Trigger and Time Base System
Figure 2-4. Front-panel Facilities, Horizontal Deflection System
Figure 2-5. Initial Setup of Type 701 Oscilloscope

We know that you are anxious to get acquainted with your new instrument. To aid you in this endeavor, you may set up the instrument using the built-in calibrator signal to demonstrate the effects of the various controls on the display. See Figure 2-5.

2-2. ADJUSTMENT OF Y BAL CONTROL

When the Y BAL control is properly adjusted, there will be no depositioning of the beam when the PULL VARIABLE control is activated. To adjust, proceed as follows:

1. Set Y VOLTS/CM switch to OFF and pull out the Y PULL VARIABLE control and rotate it fully counterclockwise.
2. Center the trace with the POSITION controls.

Note: It may be necessary to depress and hold the BEAM FINDER button and adjust the Y BAL control to position the trace on the screen.

3. Turn Y PULL VARIABLE control clockwise.
4. Adjust the Y BAL control to recenter the trace.
5. Repeat this procedure until there is no depositioning of the spot when rocking the Y PULL VARIABLE control back and forth.

2-3. THERMAL CUTOUT

A thermal cutout switch is connected in series with one side of the power line of this instrument. When the interior temperature of the instrument exceeds the safety limit, the thermal cutout switch will trip removing power from the unit. It will reset itself when the interior temperature drops to a safe value. Possible causes of over-heating are restriction of air circulation or high ambient temperature. Rack installation should be designed with a nominal clearance of 2 inches all around (1½ inches minimum) and hot air must not be circulated through the oscilloscope.

2-4. PRECAUTION AGAINST SCREEN BURNING

A sharply focused spot of high intensity and small area should not be permitted to remain stationary on the screen for any length of time. Under such conditions, the entire beam energy is concentrated over a small area, thus subjecting the screen material to burning and discoloration. This condition is most likely to exist when using the unit for X-Y plotting with the INTENSITY control turned up, and with no signal to deflect the beam.

2-5. ILLUMINATED SCALE

The adjustable scale lighting control labeled SCALE ILLUM may be adjusted to suit the lighting conditions of the room or the f/number on the oscilloscope camera.

The scale is accurately scribed in centimeters. These scale markings and the calibrated fixed attenuator markings and sweep rates can be used to convert deflection in centimeters into volts and seconds. Vertical sensitivities are calibrated in volts/cm and sweep rates are calibrated in seconds per centimeter which when multiplied by the number of centimeters of deflection give the voltages and seconds. An illuminated internal no-parallax graticule is optionally available. No special techniques or equipment are required to photo-record from the Fairchild Internal No-parallax Graticule.

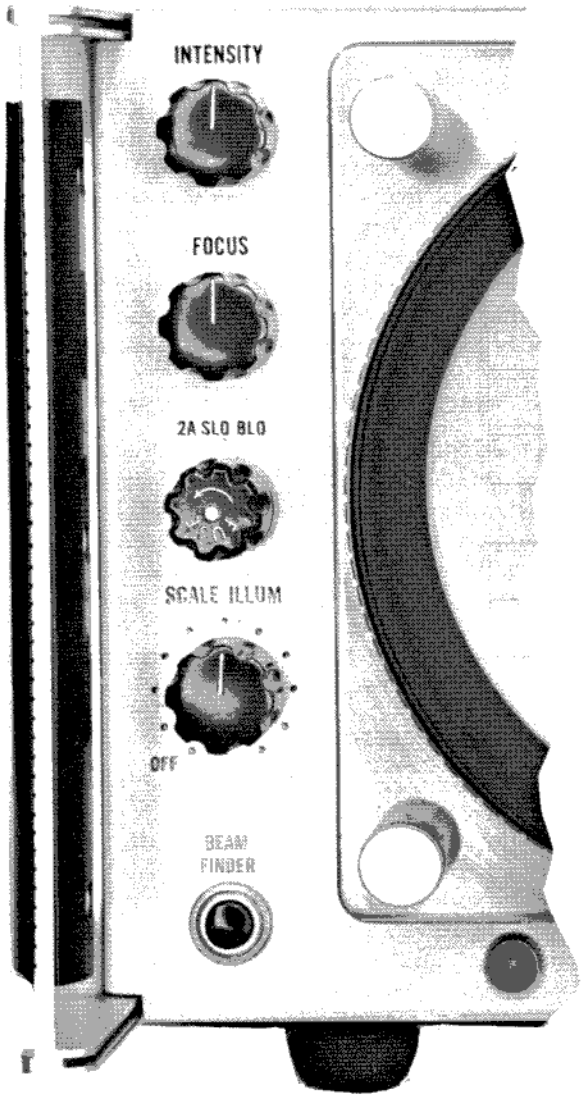
2-6. APPLYING A SIGNAL

The signal to be displayed is applied to the Y INPUT connector on the front panel. To insure proper performance, the signal should be applied through a shielded cable, with the shield connected to the chassis of both the oscilloscope and the signal source.

Accessory Probes are available for use with this oscilloscope and are listed in Section 1 of this manual.

INTENSITY

Control: varies trace brightness



FOCUS

Control: adjusts trace sharpness

SCALE ILLUM

Control with switch: dimmer control varies scale illumination; attached switch turns power on or off

PILOT LAMP

Illuminated lamp indicates application of primary power

BEAM FINDER

Spring-loaded switch: reduces amplifier output and scale down display permitting location of beam and centering with X & Y POSITION controls

Figure 2-1. Front Panel Facilities, CRT System

Y VOLTS/CM

Outer knob (black): provides a discrete, calibrated attenuator for Y input signals with amplitude as indicated on the front panel (PULL VARIABLE *in*). CAL & OFF settings also provided

PULL VARIABLE

Inner knob (red): provides a 10 to 1 variable adjustment permitting maximum gain and overlap of the Y VOLTS/CM setting; push-pull switch serves as an indicator of calibrated or vernier operation

POSITION

Control: positions trace vertically

AC/DC

Two-position slide switch: provides choice of ac or dc coupling of y input signals

Y BAL

Screwdriver control: when adjusted prevents vertical depositioning of trace when PULL VARIABLE control is activated

Y CAL

Screwdriver control: sets gain of Y amplifier for specific deflection to insure accuracy of vertical amplitude measurements

CAL 0.5V

Enables calibration check of 10:1 probe when VOLTS/CM switch is set to 10 millivolts

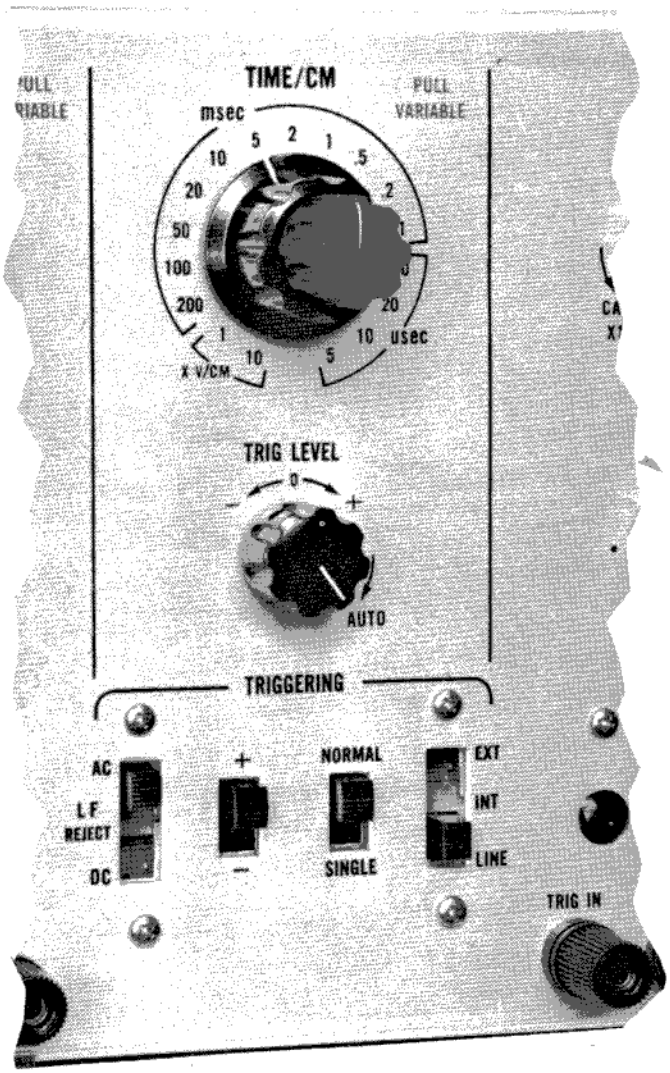
Y INPUT

Binding posts: for applying external signals to the vertical deflection amplifier. Remove ground link for differential input

Figure 2-2. Front Panel Facilities, Vertical Deflection System

TIME/CM

Outer knob (black): selects discrete, calibrated sweep rates as indicated on front panel (PULL VARIABLE *in*). X V/CM sector provides for application of X INPUT signals with attenuations of 1:1 or 10:1



PULL VARIABLE

Inner knob (red): provides a continuous, uncalibrated range of sweep rates within the limits established by the TIME/CM setting; push-pull switch assures calibrated sweep rates

TRIG LEVEL

Control with switch: selects trigger signal voltage at which the sweep is fired; switch actuation permits AUTOmatic triggering

TRIGGERING

Two, 3-position and two, 2-position slide switches: enables trigger selection from internal or external source, direct or capacitive coupling, choice of slope polarities, and normal or single sweep operation as indicated on front panel

TRIG IN

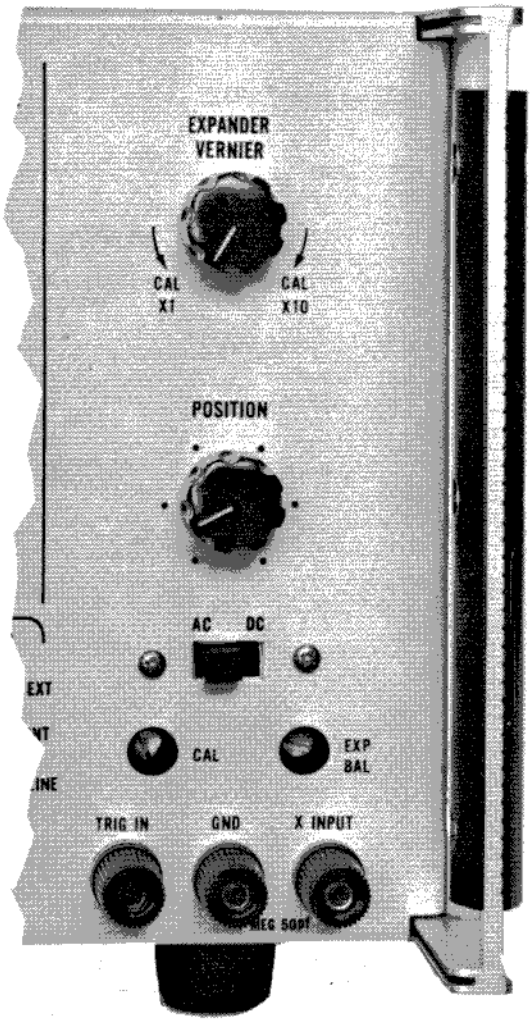
Binding post: for applying external triggering signal through EXT position of Trigger Source slide switch

Figure 2-3. Front Panel Facilities, Trigger and Time Base System

EXPANDER VERNIER

Control with two detented switch settings: EXPANDER VERNIER control provides a 10:1 continuous expansion of the internal sweep or of the X INPUT signal

The attached switch provides calibrated gain of 1 or 10 of the internal sweep or of the X INPUT signal (detented settings)



POSITION

Control: positions trace horizontally

AC/DC

Two-position slide switch: provides choice of ac or dc coupling of X INPUT signals

X CAL

Screwdriver control: sets gain of X amplifier for specific deflection to insure accuracy of horizontal amplitude and time measurements

EXP BAL

Screwdriver control: when properly adjusted, provides for equal expansion about screen center of internal or external X signals

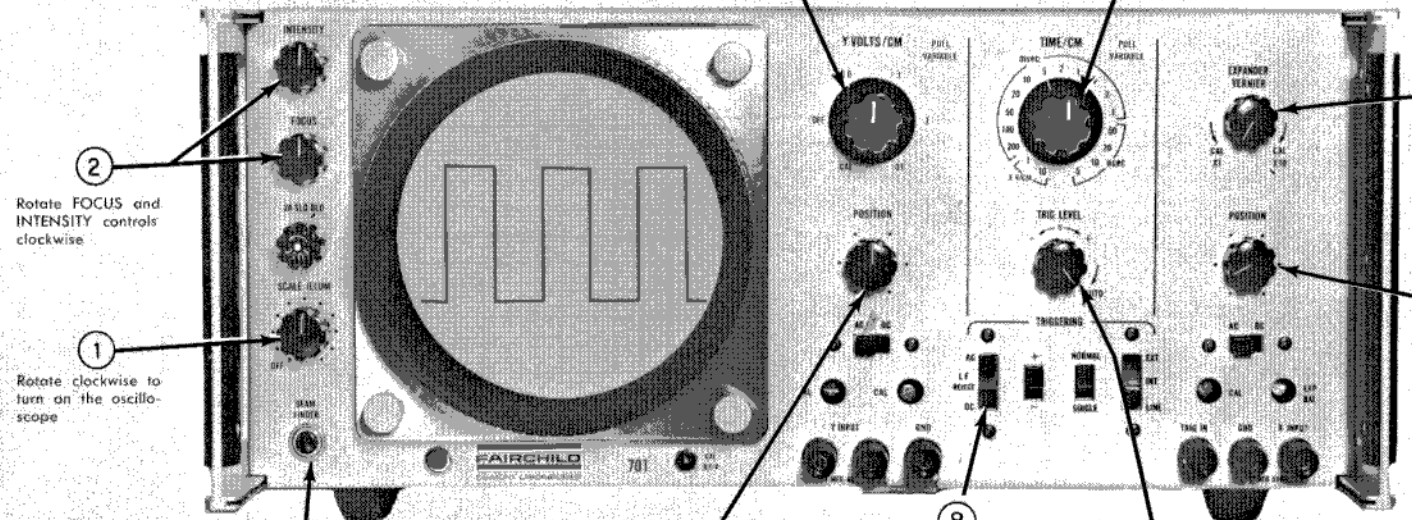
X INPUT

Binding posts: for applying external signals to the horizontal deflection amplifier via the X V/CM sector of the TIME/CM switch

Figure 2-4. Front Panel Facilities, Horizontal Deflection System

To obtain the calibrator display, set the controls exactly as shown and perform the numbered steps in sequence.

Use the same procedure when difficulty is experienced when obtaining a display. This will eliminate "cockpit" troubles due to misalignment of controls.



Push in red knob and set outer knob (Y VOLTS/CM) to CAL (3)

Push in red knob and set outer knob (TIME/CM) to 5 mSEC (4)

Set to CAL X1 (click is heard) (5)

(2) Rotate FOCUS and INTENSITY controls clockwise

(1) Rotate clockwise to turn on the oscilloscope

(6) Set to center of range. (Knob positions trace horizontally)

Set to center of range. (Knob positions trace vertically) (9)

(8) Set TRIGGERING switches to AC, +, NORMAL, LINE

(7) Rotate clockwise to AUTO until switch is actuated (click is heard)

(10) If no trace appears, depress and hold the BEAM FINDER button and readjust POSITION controls (see 6 and 9) to center the display

Readjust INTENSITY & FOCUS controls (see 2) for a sharp pattern

NOTE

Y BAL control must be properly adjusted to obtain an on-screen trace. See paragraph 2-2.

Figure 2-5. Initial Setup of Type 701 Oscilloscope

2-7. USE OF PROBES

An attenuator probe lessens both the capacitive and resistive loading caused by the oscilloscope to a minimum value. Simultaneously, while isolating the oscilloscope from the signal source, it reduces the effective sensitivity of the instrument. In other words, the displayed waveform will be reduced in amplitude by the attenuation factor of the probe. The attenuation introduced by the probe permits measurement of signal voltages in excess of those which may be accommodated by the instrument.

When using a probe to sample signals from a tuned, matched, or otherwise critical circuit, capacitive loading may cause erroneous readings. In these cases it may be necessary to add capacity and resistance to the circuit under observation. These values should precisely equal that of the probe impedance after the probe is removed from the circuit. This substitution will equalize loading and restore the operating characteristics of the circuit under observation to the same conditions when probe measurements were made.

When using the attenuator probe to make amplitude measurements, multiply the observed amplitude of the display by the attenuation factor marked on the probe.

The Accessory Probes listed in Section 1 of this manual have an attenuation factor of 10 to 1. The maximum voltage that may be applied to these probes is 1200 volts peak-to-peak, 600 volts dc. Voltages in excess of this value (either dc volts or peak ac volts) may cause damage to components inside of the probe housing.

IMPORTANT: Before using the probe, always check its adjustment.

An adjustable capacitor in the probe compensates for variations in input capacitances from one unit to another. To insure accuracy in pulse and transient measurements, check the probe adjustment frequently. To check the probe, proceed as follows:

1. Connect the probe to the Y INPUT connector and apply the probe tip to the 0.5V CAL pin jack on the front panel.
2. Set Y VOLTS/CM switch to 10 mV and adjust the oscilloscope sweep to display several cycles of the calibrator waveform.
3. Adjust the variable capacitor in the body of the probe for a flat-top trace on the screen.

To preserve the waveform of the signal being displayed, clip the probe ground lead to the chassis of the equipment being tested. Select a short clean ground point near the probe input connection.

2-8. AC OR DC COUPLING

The AC/DC two-position slide switch permits choice of retaining the dc level of the input signal or blocking the dc component of the input signal by inserting a capacitor in series with the input. If it is desired to display both the ac and dc components of a signal, set the slide switch to DC. Thus, the position of the display at any instant is a function of the instantaneous signal voltage with respect to ground.

There are times when it is neither necessary nor desirable to display the dc component of the input waveform. A capacitor placed in series with the input connector will exclude the dc component while simultaneously permitting the ac component to be displayed. This is accomplished when the slide switch is set to AC. The effect of the dc component is now excluded from the display.

2-9. DIFFERENTIAL INPUT FEATURES (Figure 2-6)

For Y differential input, remove the link from the normally grounded Y INPUT binding post and apply the signals to it and the normal input terminals. The differential input feature is available only on the 0.1 position of the Y VOLTS/CM switch.

One of the salient features of the three-terminal balanced-to-ground input circuit is the behavior of the differential amplifier. This circuit makes it possible to reject to a considerable degree any common-mode signal, while at the same time passing and amplifying the differential input signal. Thus, if there is any balanced-to-ground pickup of noise on test leads or in the equipment under test, such noise will be reduced materially on passing through the differential amplifier circuit.

2-10. OBTAINING A DISPLAY

To use the Type 701 Oscilloscope to obtain a display, proceed as follows:

1. Signals to be observed are connected to the Y INPUT binding post via shielded cable or an attenuator probe.
2. Establish a common ground between the oscilloscope chassis and the signal source.
3. The AC/DC two-position slide switch permits choice of capacitive or direct coupling of the signal to the compensated attenuator as discussed earlier.
4. Adjust the appropriate Time Base controls to obtain a stable display of the pattern. Use of the Auto trigger mode may be desirable in setting up the display.
5. Set the Y VOLTS/CM switch and POSITION controls such that the size and position of the display is as desired on the screen. If necessary, use the BEAM FINDER push button to speedily locate the display.

In addition to the preceding 5 steps, observe the following precautions when applying signals to the oscilloscope:

1. Avoid errors in readings due to stray coupling between circuits, particularly in the signal lead. As a rule, do not use long unshielded leads for applying

signals to the oscilloscope. This fact holds for the audio-frequency spectrum, except possibly when making measurements on low impedance circuits at very low frequencies. Coaxial or shielded input cables are recommended for most applications.

2. In broadband applications, it may be necessary to terminate a coaxial cable with a resistance equal to its characteristic impedance. This is done to prevent standing waves or ringing (high-frequency damped oscillations).

3. To avoid erroneous results, the operator should simulate the actual operating conditions of the equipment being tested. For example, the equipment should work into a load impedance equal to that which it will see in actual use.

4. Consider the effect of loading upon the signal source due to the input impedance of the oscilloscope. The input impedance can be represented by a resistance shunted by a capacitance. The effective value of this impedance is indicated in the Technical Summary of this manual. However, the operator should be aware that even with a few feet of cable in the input circuit, the loading capacitance on the circuit under investigation might be greater than 100 pf ($\mu\mu$f).

5. There are cases when connecting the input of the oscilloscope to a signal source, the effect of loading the source is not negligible. To minimize this loading and therefore obtain a valid measurement, a probe may be used in the manner described in the paragraph entitled "Use of Probes."

6. Care must be exercised when applying a fast rise, high-frequency signal to the input connector. It will be necessary to match and properly terminate the coaxial cable applying the signal to the oscilloscope.

7. As the length of the cable is increased, the necessity for proper termination becomes very important. This termination is generally inserted at the oscilloscope end of the cable, although many signal sources may require an additional termination at the other end of the cable. The Type 4285 Termination is recommended for 50-ohm systems.

For rack-mounting systems, observe the following precautions if long shielded cables are used.

1. It may be desirable to ground long shielded leads only at one end to avoid circulation currents. Even micro-amperes of extraneous currents in the shielded braid will cause unwanted distortions.

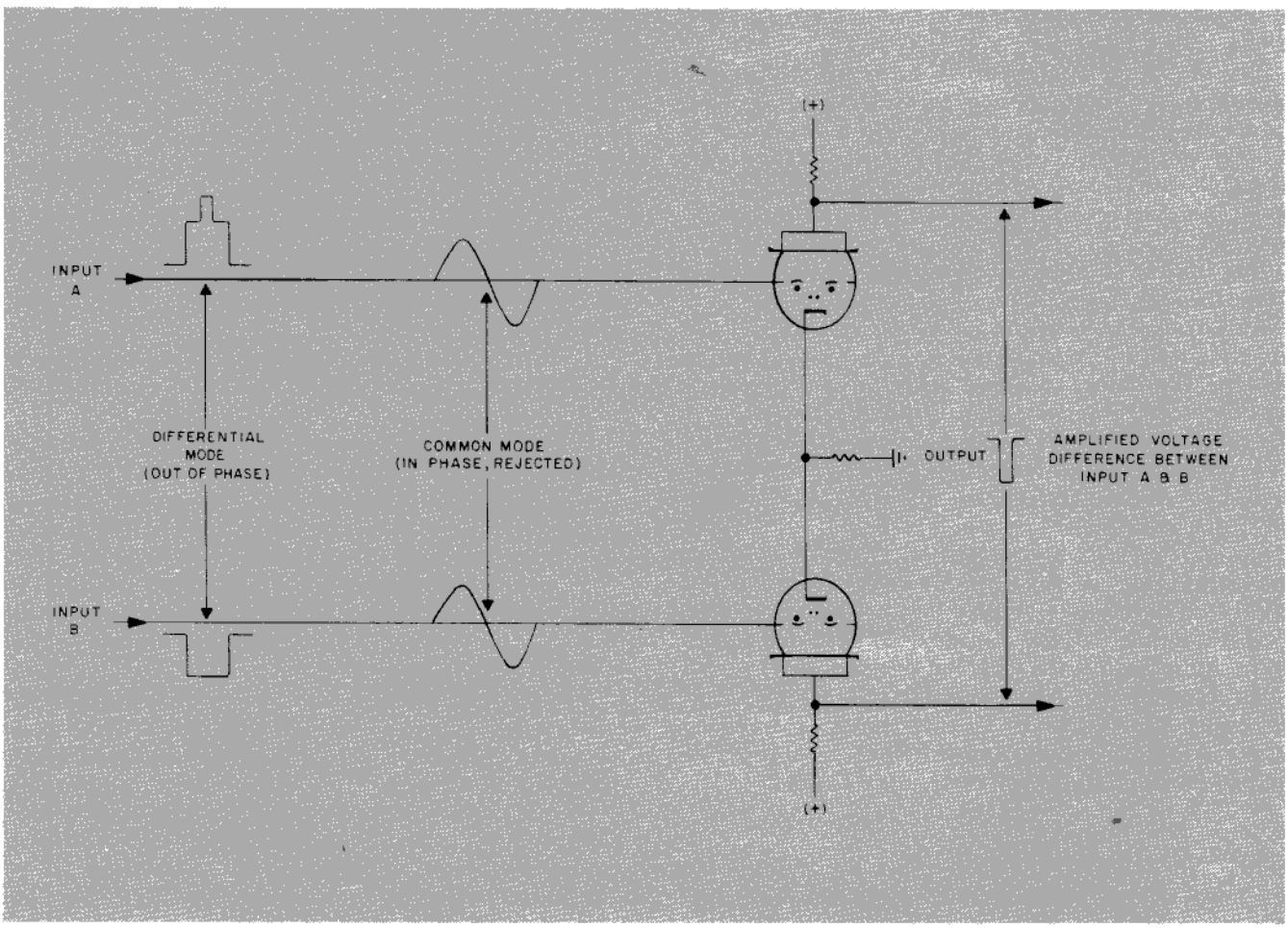


Figure 2-6. Illustrating Differential Operation

2. Use cable with insulation over the shielded braid so that the cable shield does not accidentally touch ground.

3. Use off-ground insulated bulkhead feed-thru connectors where applicable.

4. Do not pass cables near strong ac magnetic fields.

5. Long shielded input cables may also induce parasitic oscillations. It is suggested that a 100-ohm to 1000-ohm, ½-watt resistor be connected in series with the center conductor near or at the oscilloscope input terminals.

6. Use a resistance at least twice that required to just stop the parasitic oscillations. Too large a value may reduce the bandwidth of the system.

2-11. X & Y CAL ADJUSTMENT

To properly normalize the gain of the instrument, proceed as follows:

1. Set up the oscilloscope as indicated in Figure 2-5.

2. Adjust the Y CAL front-panel screwdriver control for precisely 5 centimeters of vertical deflection.

3. Adjust the X CAL front-panel screwdriver control for precisely 3 cycles of the calibrator signal. (60-cycle line.)

2-12. SWEEP TRIGGERING

To obtain a stable display, the sweep must consistently start at the same point of a repetitive input waveform. If the sweep is not synchronized to the input waveform, the displayed pattern will be traced out at a different point on the screen each time the sweep runs. This will either cause the waveform to drift across the screen or to be unintelligible. The sweep therefore must be triggered by the input signal, or by some signal which bears a fixed time relationship to the input signal. For present purposes, the starting of each horizontal wave across the screen may be called "triggering the sweep." The following instructions tell you how to select and use the proper triggering signal for various applications.

2-13. TRIGGER SOURCE SELECTION

a. Internal

For most applications, the sweep may be triggered by the Y input signal. The only requirement is that the signal amplitude be sufficient to trigger the sweep. To obtain triggering of the sweep from the input signal, set the Trigger Source switch to INT. Internal triggering is convenient since no external triggering connections are required. Satisfactory results are obtained in most applications.

b. External

Sometimes it is advantageous to trigger the sweep with an external signal. External triggering is especially useful where signals are going to be sampled from several different places within an instrument. With external triggering, the triggering signal usually remains constant in amplitude and shape. Thus, it is possible to observe the shaping and amplification of a signal in an external circuit without resetting the oscilloscope triggering controls for each observation. Also, time and phase relationships between the waveforms at different points in the circuit can be seen. For example, if the external triggering signal is derived from the waveform at the input to a circuit, the time relationship and phase of the waveforms at each point in the circuit are compared to the input signal by the displayed waveform.

When a stable, external triggering signal is available, it is possible to observe and accurately measure jitter of the displayed waveform with respect to the trigger input signal. This is not possible when the sweep is triggered internally. Internal triggering will not permit base line to show on screen prior to the rise of the signal being observed. A trigger preceding the signal may be used to externally trigger the oscilloscope to display the entire signal.

To obtain a stable display, the external triggering signal must have an amplitude of at least 0.5 volt, peak-to-peak and bear a fixed time relationship to the displayed signal. To use an external signal for triggering the sweep, connect the signal to the TRIG IN connector and set the Trigger Source switch to EXT.

c. Line

If the pattern on display bears a fixed time relationship to the power-line frequency, the sweep may be triggered by this signal. To accomplish this, set the Trigger Source switch to LINE.

2-14. TRIGGER COUPLING SELECTION

a. AC Coupling

Selection of the AC triggering mode is accomplished by setting the Trigger Coupling switch to AC. This mode is provided with a high-pass filter that has a low-frequency cutoff nominally at 80 cycles. This feature prevents erratic triggering when positioning the pattern vertically while using internal triggering. In the AC mode, triggering is unaffected by the dc components of the triggering signal or by the vertical positioning of the trace. The triggering level can be selected to provide the desired display via use of the TRIG LEVEL control.

When using the AC mode, the Trigger Coupling switch is set to AC. The trace always starts at the same point on the *Waveform* for a given TRIG LEVEL control setting regardless of the vertical positioning.

Note: DC coupling triggering on the line-frequency calibrator signal or square wave signals less than 100 cycles may be erratic since the 80-cycle cutoff filter severely integrates the trigger.

b. DC Coupling

The DC mode is especially useful for viewing waveforms which change very slowly and which are therefore discriminated against by the low-frequency cutoff of the AC position (80 cps). Because of the coupling network time constant in the AC mode, signals having random repetition rates are sometimes viewed more stably in the DC mode.

This mode permits excellent triggering on all types of waveforms and is most useful in the following applications:

1. For optimizing trigger sensitivity or operation when low-frequency signals are applied;
2. For maintaining the initial reference position of the trace with respect to the CRT scale at a given TRIG LEVEL control setting when on Internal source; and
3. For avoiding trigger point variations due to random repetition rate triggering signals.

When using the DC mode, the Trigger Coupling switch is set to DC. The trace always starts at the same point on the *Scale* for a given setting of the TRIG LEVEL control regardless of the vertical positioning.

c. LF Reject Coupling

The LF REJECT mode is a special high-frequency form of the AC mode and is used to reject low-frequency components in the triggering signal. Use AC triggering unless low-frequency rejection is required. Triggering signals with frequency components below 15 Kc, for example the calibrator signal, will not initiate the sweep circuits when the LF REJECT mode is used. To insure stability, the triggering signal should rise in less than 100 μsec.

Occasionally it is required to obtain stable triggering from a complex high-frequency waveform that contains undesirable low-frequency noise or line-frequency components. In such cases, the additional noise and line pickup may make it difficult to obtain a stable display. If this occurs, select the LF REJECT triggering mode, thereby eliminating the effects of these undesired components. The low-frequency components are blocked from the triggering circuit while the high-frequency triggering waveform is passed to produce the stable triggering that is required. In all other respects, the LF REJECT triggering mode is identical to the AC mode.

2-15. TRIGGER SLOPE SELECTION

When the Trigger Slope switch is set to +, the sweep is triggered on the rising or positive slope of the excitation signal. When the Trigger Slope switch is set to −, the sweep is triggered on the falling or negative slope of the excitation signal.

2-16. TRIGGER LEVEL SELECTION

The TRIG LEVEL control permits selection of a specific voltage which the triggering signal must exceed before the sweep fires. When the Trigger Slope switch is set to the + position, adjustment of the TRIG LEVEL control makes it possible to trigger the sweep consistently on the positive slope of the excitation signal. Conversely, with the Trigger Slope switch set to the − position, adjustment of the TRIG LEVEL control makes it possible to trigger the sweep consistently on the negative slope of the excitation signal. See Technical Summary for trigger level ranges.

2-17. SWEEP OPERATIONAL MODES

a. Introduction

When the Trigger Mode switch is set to NORMAL, the oscilloscope may be set up for triggered or automatic sweep. In the SINGLE mode, the time base moves but one stroke until manually reset.

b. Automatic Sweep

In some applications, it is desirable to have the sweep free-running, whether synchronized or not. When using the AUTO mode, a horizontal reference trace will appear on the screen even in the absence of an input signal. This AUTOmatic mode is very useful while testing equipment since a reference trace will always be visible regardless of whether a signal is applied to the oscilloscope or not.

The AUTO mode simplifies synchronization of signals or periodic waveforms having repetition rates greater than 50 cycles.

To obtain AUTOmatic sweep operation, set the TRIG LEVEL control fully clockwise to AUTO (switch is actuated) and the Trigger Mode switch to NORMAL.

c. Triggered Sweep

A stable pattern for practically all types of signals can be obtained by using triggered sweep. Its use is mandatory for viewing random or non-periodic signals having low repetition rates. Use of the triggered sweep mode of operation in the majority of applications is the preferred condition under which optimum triggering performance can be expected of this instrument.

When the oscilloscope is set for triggered sweep, the spot will be visible only during forward sweep time. The INTENSITY control must be properly adjusted to make the sweep visible. For triggered sweep operation, proceed as follows:

1. Apply the desired signal to Y INPUT and set front-panel controls as previously indicated in Figure 2-5.
2. Adjust Y PULL VARIABLE control in conjunction with Y VOLTS/CM switch to obtain a vertical deflection of approximately 5 centimeters.

3. Adjust TRIG LEVEL control to initiate the sweep and the POSITION controls to center the display.

4. Rotate the TIME/CM and PULL VARIABLE controls to obtain the desired display. Readjust the TRIG LEVEL control if necessary.

5. Adjust INTENSITY and FOCUS controls to obtain a sharp trace of suitable brightness.

6. If there is any multiple triggering of the sweep, the TRIG LEVEL control may be adjusted to select the signal levels which will best actuate the trigger circuit. Thus, undesirable signals of lesser amplitude will be rejected by the trigger channel.

7. Set Trigger Coupling switch to LF REJECT to obtain a more stable display when using high-frequency triggering signals. Use DC coupling when the triggering waveform is very slow.

d. Single-Sweep Operation

Single-sweep operation infers that the time base moves but one stroke until reset. Using a repetitive sweep to view a varying waveform would result in an overlapped and unintelligible display caused by many cycles of the single trace being superimposed on one another. However, when it is desired to view a single display of an input signal which continually varies in amplitude, shape, or time, the Trigger Mode switch should be set to SINGLE for single-sweep presentation. Thus, by commanding but one stroke of the sweep at a time, the SINGLE position eliminates the overlapping caused by the multiple traces and enables the display to be viewed and/or recorded clearly.

A single trace will sweep across the screen each time the sweep is triggered and at the end of its travel, the beam will rest off screen. To rearm the sweep, set the Trigger Mode switch from SINGLE to NORMAL and back to SINGLE position. The sweep is now armed and ready to fire on the next trigger.

Note: Do not use AUTOmatic triggering or have continuous input of triggers since single sweep will not reset or function properly.

For manual single-shot operation, proceed as follows:

1. Set Trigger Mode switch to NORMAL and Trigger Source switch to INT.

2. Adjust TRIG LEVEL control until sweep just disappears.

3. Set Trigger Mode switch to SINGLE.

4. Flip Trigger Polarity switch up and down; sweep will fire once. (Rocking the TRIG LEVEL control will also cause the sweep to fire just once.)

5. Reset Trigger Mode switch to SINGLE.

6. Repeat steps 4 and 5 for controlled manual single-shot operation.

2-18. SWEEP EXPANSION

a. Uncalibrated

If the EXPANDER VERNIER control is not set either fully CW or CCW (switch is not actuated) continuous expansion about the center of the screen from 1 to 10 times may be obtained. Any full scale portion of the expanded trace may be positioned on screen.

b. Calibrated

When the EXPANDER VERNIER control is set to CAL X1 (click is heard when switch is actuated) the sweep rate is that indicated by the setting of the TIME/CM switch.

The CAL X10 setting of the EXPANDER VERNIER switch (click is heard) provides horizontal magnification of the internal sweep about the screen center by a factor of 10. Thus, the fastest sweep rate is extended to 0.5 microsecond/cm. Any portion of the expanded display may be observed by adjusting the POSITION control.

When the instrument is set up for sweep expansion, the sweep rate indicated by the setting of the TIME/CM control must be divided by the expander factor of 10 to obtain the actual time required for the spot to move one centimeter. The expanded sweep rate may be expressed as follows:

$$\text{Expanded Sweep Time/Cm} = \frac{\text{TIME/CM setting}}{10}$$

For example, if the TIME/CM control is set to 10 mSEC, and the EXPANDER VERNIER switch is set to CAL X10, the actual time per centimeter is 10 milliseconds, divided by 10, or 1 millisecond per centimeter.

$$\text{Or using the formula: } \frac{10 \text{ msec/cm}}{10} = 1 \text{ msec/cm}$$

2-19. INTENSITY (Z AXIS) MODULATION

The Type 7088 Z Axis Modulation option is available as an accessory for intensity modulation of the trace. Installation instructions are furnished with each kit.

Negative pulses to the grid of the cathode-ray tube will blank the trace. Pulse amplitude of more than 25 volts is required into an impedance of approximately 600K ohms coupled via a 3300 picofarad capacitor to dim the trace.

2-20. X-Y DISPLAYS

When desiring to view one voltage plotted against another (not the internal time base), simply connect the signals to the X and Y Input terminals and adjust

the oscilloscope controls to obtain an appropriate display on the cathode-ray tube screen. The TIME/CM control must be set to one of the two X V/CM settings (1 or 10) for X-Y display.

CAUTION

KEEP INTENSITY LOW

Screen damage can result from too intense a beam resting at one point on the screen.

2-21. VOLTAGE MEASUREMENTS

NOTE

When making voltage measurements, make sure there is a common ground between the oscilloscope and the signal source.

a. General

This oscilloscope may be used to measure the voltage of the input signal by using the calibrated Y VOLTS/CM setting and observing the height of the display on the screen in centimeters.

When making voltage measurements, the operator should try to set up the instrument for full scale vertical deflection to insure maximum accuracy. Also, it is important to remember that the width of the trace may be an appreciable part of the over-all measurement. This is particularly true when you are measuring signals of small amplitude or when stray signal pickup has broadened the trace. The operator should consistently make all measurements from one side of the trace. If the top side of the trace is used for one reading, it should be used for all succeeding readings.

b. How to Measure Peak-to-Peak Voltages Using the CRT Scale

The procedure employed for all voltage measurements is basically the same. The PULL VARIABLE control must be set to CAL (pushed in). The specific examples that follow are intended to show the general procedure. These examples may be adapted to fit any particular application.

To measure the ac component of the signal on display, set the AC/DC switch to AC. In this position, only the ac components of the input signal are displayed on the screen. However, when the ac component of the input is of very low frequency (under 20 cps), set the slide switch to DC to prevent errors. To make measurements, proceed as follows:

1. Using the calibrated scale, measure the vertical deflection in centimeters from the positive peak to the negative peak of the waveform. See Figure 2-7.
2. Multiply the vertical dimension obtained in Step 1 by the Y VOLTS/CM control setting to obtain the indicated voltage.
3. Multiply the indicated voltage obtained in Step 2 by the attenuation factor of the probe, if one is used, to obtain the actual peak-to-peak voltage.

For example, suppose that you are using a 10:1 Attenuator Probe and the Y VOLTS/CM control is set to 0.1. Assume that the vertical distance between the peaks of the waveform measures 4 centimeters. Now, the vertical dimension of 4 centimeters is multiplied by the Y VOLTS/CM setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, the attenuation ratio of the probe. This gives 4 volts as the peak-to-peak voltage of the display waveform.

Note: Always make sure that the PULL VARIABLE control is pushed in when making measurements.

c. How to Measure Instantaneous Voltages with Respect to Ground (or Some Other Reference Potential) Using the CRT Scale

The technique used for measuring instantaneous voltages with respect to a reference point, is virtually the same as that described for peak-to-peak voltage measurements. The difference is that now a reference point must be established on the screen of the oscilloscope. Since voltage measurements with respect to ground are the most common, the procedure which follows establishes ground as the reference point. The same general technique may be used for instantaneous measurements with respect to any other potential, just

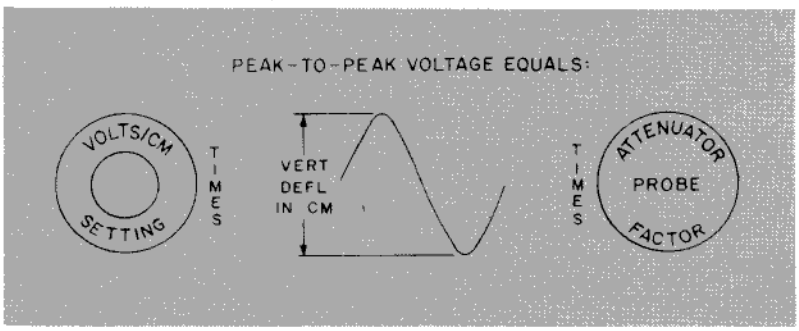


Figure 2-7. Peak-to-Peak Voltage Measurements

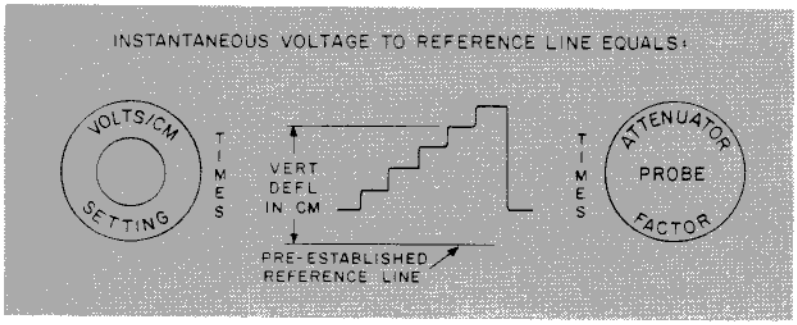


Figure 2-8. Instantaneous Voltage Measurement With Respect to Ground (or Some Other Reference Potential)

so long as that potential is employed to establish the reference point.

To make measurements, proceed as follows:

1. Set the AC/DC switch to DC.
2. Adjust the appropriate controls to obtain a reference trace.
3. To establish the reference point, touch the probe tip to the ground terminal on the oscilloscope (or to the desired source potential, if a point other than ground is used). Vertically position the trace to a convenient point on the screen. This point should be chosen so that it lies on one of the major horizontal scale divisions. The chosen horizontal scale line, which is now coincident with the trace, is the reference line from which all voltage measurements are to be made.
4. Disconnect the probe tip from ground and connect it to the signal source without disturbing the POSITION control.
5. Adjust the oscilloscope controls for a suitable and stable display.
6. Using the calibrated scale, measure the number of graticule divisions from the desired point on the waveform to the pre-established reference line set up in step 3. See Figure 2-8.
7. Multiply the vertical dimension obtained in Step 6 by the Y VOLTS/CM control setting to obtain the indicated voltage. Make sure that the PULL VARIABLE knob is pushed in.
8. Multiply the indicated voltage obtained in Step 7 by the attenuation factor of the probe used to obtain the actual instantaneous voltage.

For example, suppose that you are using a 10:1 Attenuator Probe and the Y VOLTS/CM control is set to 0.1. Assume that the vertical distance between the desired point on the waveform to the pre-established reference line is 4 centimeters. Now, multiply this vertical deflection of 4 centimeters by the Y VOLTS/CM setting of 0.1 to give 0.4 volt. Next, multiply this result by 10, the attenuation factor of the probe. This shows that the instantaneous voltage with respect to ground to be 4 volts. Since the voltage point is above the reference line, the indicated polarity is positive.

2-22. TIME MEASUREMENTS

a. How to Make Elapsed Time Measurements Using the CRT Scale

Any horizontal distance on the screen of the oscilloscope can be used to represent a precise interval of time when the time-base circuits are set up for calibrated sweep (PULL VARIABLE control "in"). Use of this feature permits you to accurately measure the elapsed time between the desired point of interest on the display. To measure the time interval, proceed as follows:

1. Using the calibrated scale, measure the horizontal distance in centimeters between that portion of the display whose time interval you wish to find.
2. Multiply the horizontal dimension obtained in Step 1 by the TIME/CM control setting to obtain the time interval. See Figure 2-9.

b. How to Find Repetition Rate or Frequency Using the CRT Scale

The repetition rate or frequency for periodic signals can be expressed as the number of cycles or pulses per unit of time. To use the oscilloscope for measuring the repetition rate or frequency of periodic signals, proceed as follows:

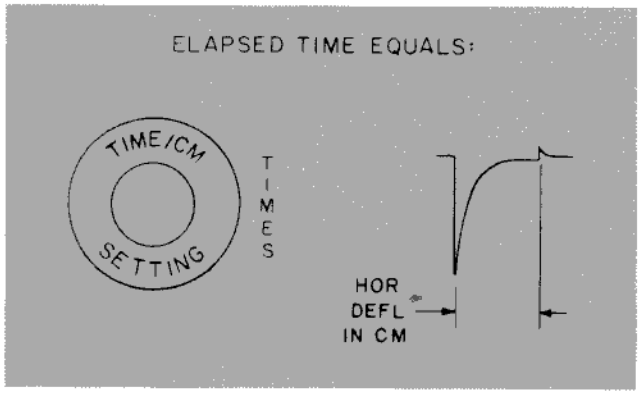


Figure 2-9. Elapsed Time Measurement

1. Using the calibrated scale, measure the horizontal distance in centimeters occupied by one cycle of the display under observation.

2. Multiply the horizontal dimension obtained in Step 1 by the TIME/CM control setting.

3. Take the reciprocal of the product obtained in Step 2 (that is, divide it into one). The resulting quotient is the desired frequency or repetition rate in cycles per second. See Figure 2-10.

$$\text{Cycles/second} = \frac{1}{\text{Time (seconds)}}$$

2-23. RISE-TIME MEASUREMENTS

Application of signals from an external time calibrator will facilitate pulse rise-time measurements. When making such measurements, the one factor which must be borne in mind for most accurate quantitative results is the pulse response characteristic of the vertical amplifier. This characteristic is related to the observed pulse rise time and the actual pulse rise time in the following manner:

$$t_p = \sqrt{(t_o)^2 - (t_a)^2}$$

Where: t_p = actual pulse rise time in microseconds

t_o = observed rise time of pulse displayed on oscilloscope in microseconds

t_a = amplifier rise time in microseconds

Once the amplifier rise time is known, the rise time of any pulse may be calculated.

To make rise-time measurements, proceed as follows:

1. Adjust pattern for full scale (10 cm) of vertical deflection.

2. Using the X and Y POSITION controls, adjust the display vertically so that the start of the waveform rests 1 centimeter below the scale horizontal center line and the rising portion of the waveform intersects the zero point on the scale (labeled A in Figure 2-11). Observe that the top of the waveform is off screen. Be careful not to accidentally change the setting of the X POSITION control.

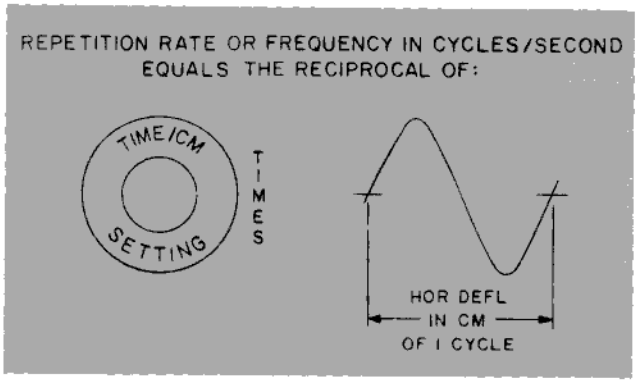


Figure 2-10. Finding the Frequency

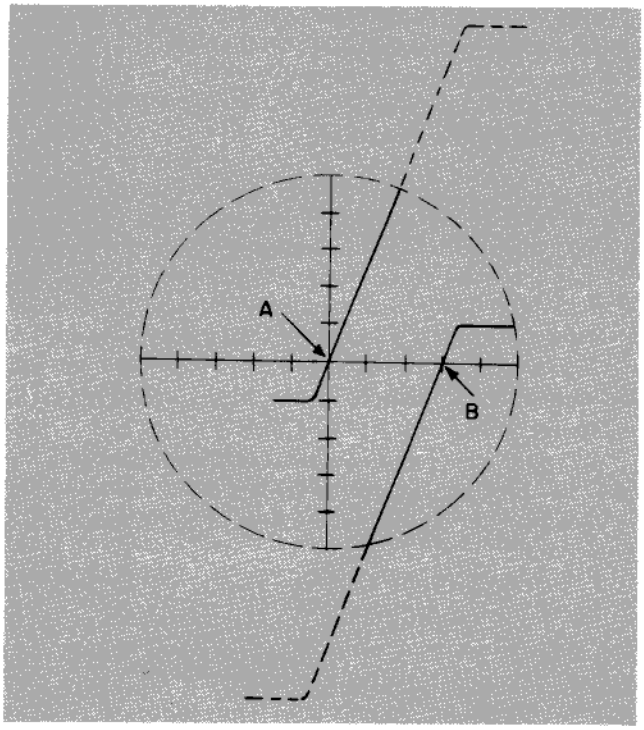


Figure 2-11. Rise-Time Measurement

3. With the Y POSITION control, move the waveform down until the top portion of the waveform rests 1 centimeter above the horizontal center line.

4. Note where the rising portion of the waveform intersects the X axis (labeled B in Figure 2-11).

5. Measure the distance between points A and B, multiply this reading by the TIME/CM switch setting to obtain rise time.

6. For example, if the distance between points A and B is 3 centimeters and the TIME/CM switch is set to 5 μs, the rise time would be 15 μs.

7. Rise-time measurements made in this manner eliminate errors which would result from improper deflection plate alignment and incorrect interpolation.

8. Rise time of the amplifier may be checked by applying a pulse with an input rise 5 or more times faster than the amplifier. (Use Fairchild Type 791 Square Wave Generator.)

2-24. PHASE SHIFT MEASUREMENTS

Phase shift measurements are usually made when the frequencies of the two input ac signals are equal. Hence, Lissajous figures that results from a phase difference between two input signals of the same frequency are often referred to as phase difference patterns. When the frequencies of the two input signals are not a 1:1 ratio, the Lissajous figures are generally used for frequency measurements.

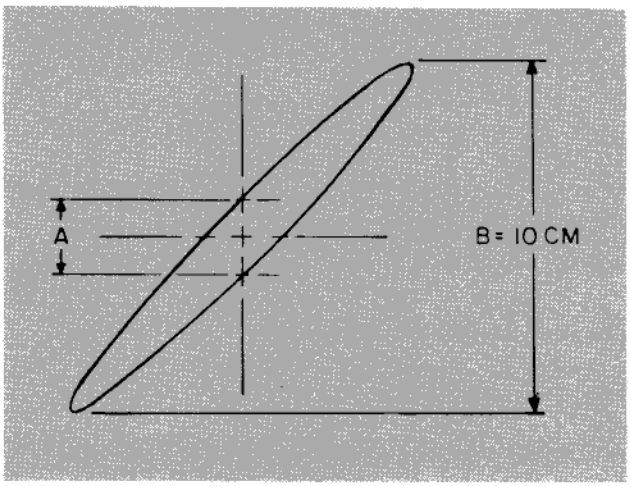


Figure 2-12. Phase Shift Measurement

To check the relative phase shift, proceed as follows:

1. Apply a sine wave signal to both the X and Y INPUT.

2. Center the trace horizontally and adjust the Y controls for 10 centimeters of vertical deflection. The pattern obtained should be similar to Figure 2-12.

3. The angle between the two signals is that angle whose sine is the ratio of A/B.

Note: To obtain full scale vertical deflection of 10 centimeters, it may be necessary to temporarily reduce the horizontal amplitude of the display. To accomplish this, set the X VOLTS/CM switch one step counterclockwise from its initial setting. Adjust the display for 10 centimeters of vertical deflection. Reset X VOLTS/CM switch to its original setting, recenter the display, and read dimension A in Figure 2-12.

SECTION 3
CIRCUIT DESCRIPTION

3-1. INTRODUCTION

To simplify circuit description of the Type 701 Oscilloscope, functional block diagrams are provided as follows:

Figure 3-1. Y Input Circuit, Simplified Functional Block Diagram
Figure 3-2. Y Deflection Amplifier, Functional Block Diagram
Figure 3-3. X Input Circuit, Simplified Functional Block Diagram
Figure 3-4. X Deflection Amplifier, Functional Block Diagram
Figure 3-5. Trigger Circuit, Functional Block Diagram
Figure 3-6. Sweep Generator, Simplified Block Diagram

The circuit description will be keyed to the aforementioned illustrations. Emphasis is placed on the interrelation of circuits rather than on detail of operation. It is also recommended that the schematics at the rear of the manual be referred to in following the circuit description.

3-2. VERTICAL DEFLECTION SYSTEM

a. Input Circuit (Figure 3-1)

A two-position slide switch (AC or DC) permits choice of retaining the dc level of the input signal or blocking the dc component of the input signal by inserting a capacitor in series with the input.

The Y VOLTS/CM switch permits the desired attenuation of the input signal from 10 millivolts/cm to 10 volts/cm in 4 decade steps. In the CAL position, the calibrator signal is applied to the input of the input amplifier V1001, and may be used to normalize the oscilloscope. When gains are normalized, the peak-to-peak value of the calibrator waveform will indicate 5 centimeters of vertical deflection on the screen.

An OFF position is provided on the Y VOLTS/CM switch to facilitate the dc balancing of the input amplifier.

b. Vertical Deflection DC Amplifier Operation (Figure 3-2)

The normally grounded grid of V1001 (pin 2) is brought out to the front-panel binding post so that

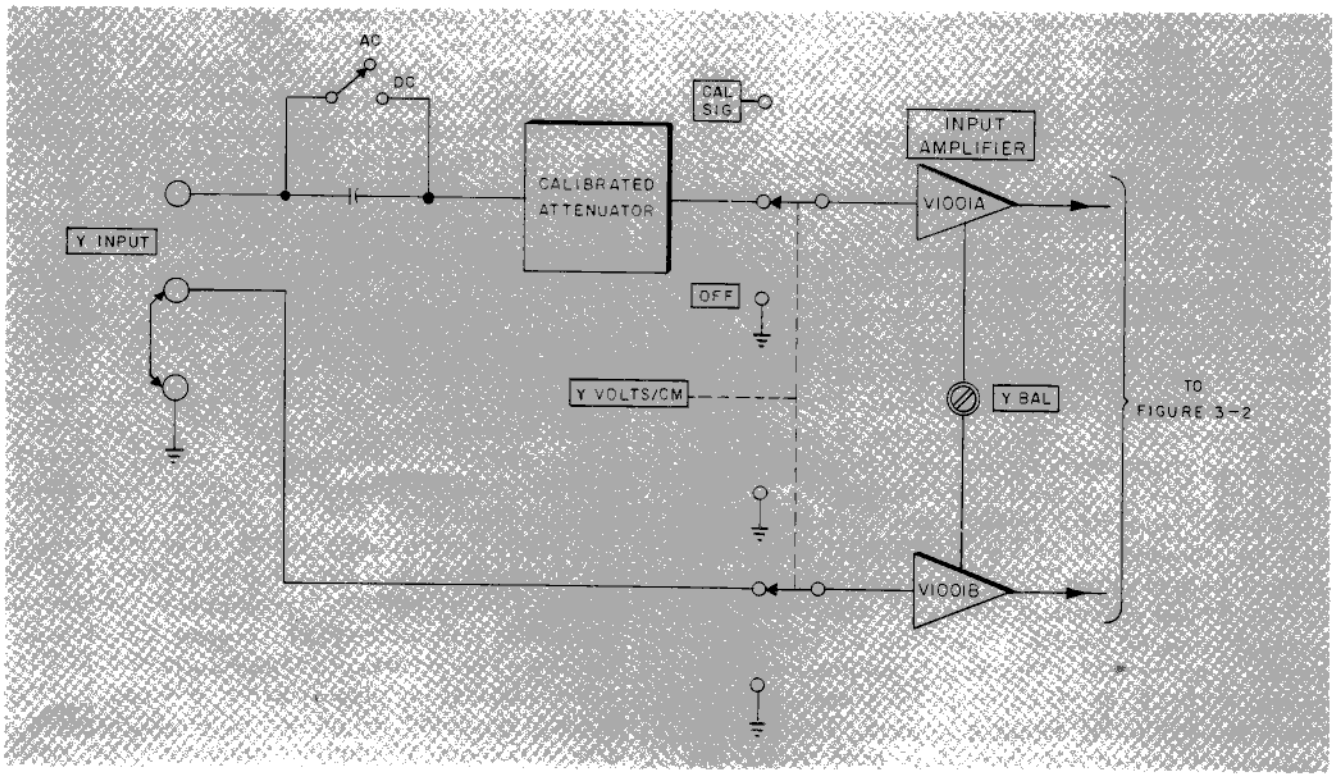


Figure 3-1. Y Input Circuit, Simplified Functional Block Diagram

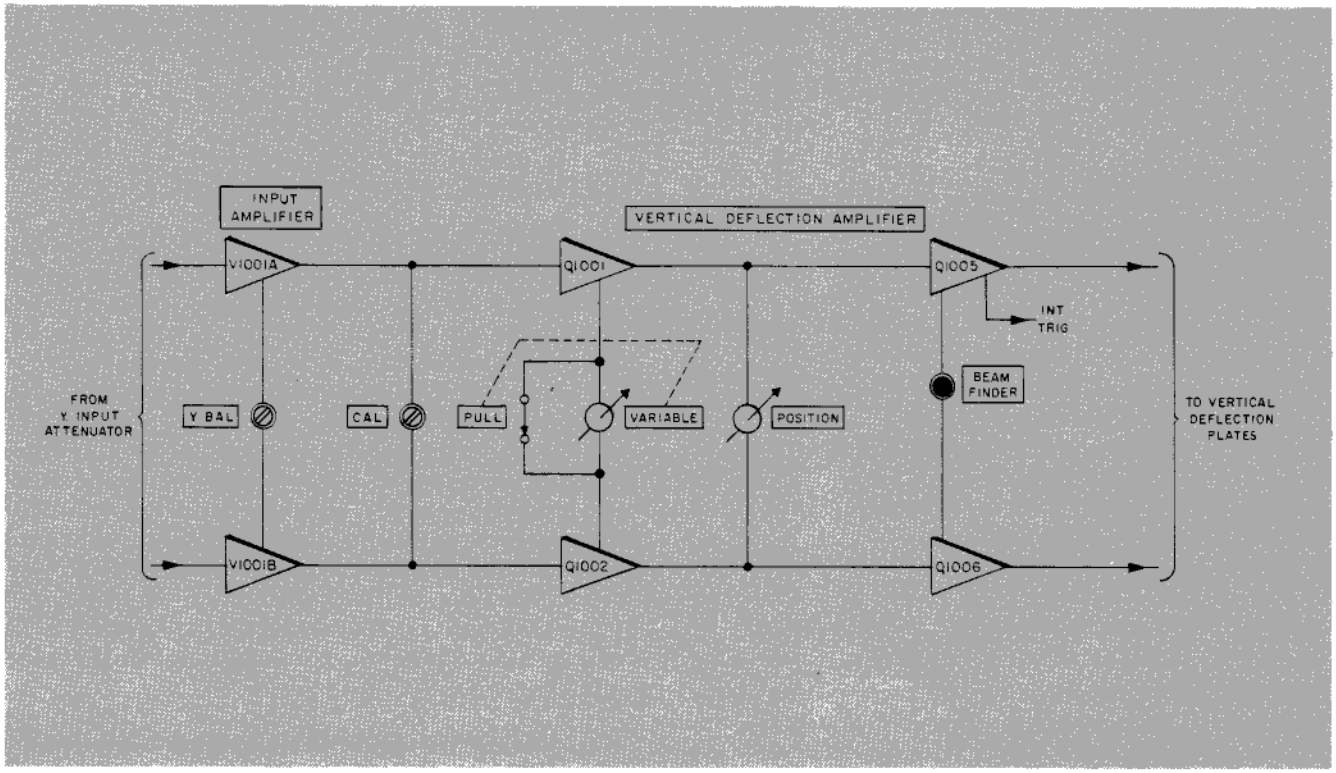


Figure 3-2. Y Deflection Amplifier, Functional Block Diagram

balanced input operation may be obtained by merely removing the ground link.

The RC networks, R1001 and C1005, and R1003 and C1007, in series with the grid of V1001A and V1001B respectively, serve to protect the input circuit from damage due to excessive input voltage. The shunt capacitors preserve the high-frequency signal components.

The PULL VARIABLE control is connected between the emitters of transistors Q1001 and Q1002 in the gain control stage, and is deactivated when the knob is pushed in. The front-panel screwdriver BAL control is provided to equalize the emitter voltage of Q1001 and Q1002 so that there is no depositioning of the trace on the screen when the PULL VARIABLE control is used. To use the VARIABLE control, pull the knob and rotate it for the desired amplitude. Note that greater than calibrated gain may be obtained when the VARIABLE control is rotated fully clockwise.

An internal calibrating voltage is applied to the vertical input dc amplifier when the Y VOLTS/CM switch is set to CAL. This switch automatically disconnects the Y INPUT signal from the amplifier when the calibrator signal is applied. The Y CAL front-panel screwdriver control is used to set the calibrated gain of the Y amplifier to the peak amplitude of the calibrator signal (5 cm). The Y OUTPUT LEVEL ADJ potentiometer R1059 is provided to set the Y deflection plate voltage to 118 volts (nominal) above chassis ground when the collectors of Q1005 and Q1006 are temporarily shorted together.

The BEAM FINDER is a momentary contact switch that electrically reduces the output amplifier window and scales down the display. This technique permits location of the display and then allows centering with the POSITION controls.

The BEAM FINDER control is extremely useful for locating the spot or trace under any condition of operation. If no spot or trace appears when the BEAM FINDER button is depressed, only two conditions can cause this: either the INTENSITY control has to be advanced or else the sweep is not running. It may aid the operator to set up the instrument for AUTOmatic triggering in an endeavor to obtain a trace on the screen.

A phase shift trimmer C1012, is added across the output of the vertical deflection amplifier Q1005 and Q1006. This trimmer enables an operator to optimize the phase shift differential between the X and Y amplifiers for a particular application. When C1012 is not adjusted for phase balance at a particular frequency, it should be set for minimum capacity to give maximum Y amplifier response. The vertical deflection plates are driven directly from the transistorized amplifier Q1005 and Q1006.

3-3. HORIZONTAL DEFLECTION SYSTEM (Figures 3-3 and 3-4)

The TIME/CM switch provides for the selection of time base or external signals for horizontal deflection. External signals may be applied to the X INPUT terminal for single-ended operation. The time base signal is obtained from the sweep circuit and is applied to the horizontal deflection amplifier when the oscilloscope is set up for internal sweep. The EXPANDER VERNIER control provides continuous adjustment from X1 to X10 for magnification of the internal time base or of external X INPUT signals. The EXP BAL front-panel screwdriver control provides for equal expansion of the trace from screen center.

The X OUTPUT LEVEL ADJ potentiometer R2029 is provided to set the X deflection plate voltage to 118 volts (nominal) above chassis ground when the collectors of Q2005 and Q2006 are temporarily shorted together. The horizontal deflection plates are driven directly from the transistorized amplifier Q2005 and Q2006.

3-4. TRIGGER CIRCUIT DESCRIPTION (Figure 3-5)

a. Trigger Input

The input to the trigger amplifier V3001, may be selected from one of three sources via the Trigger Source switch as follows:

1. In EXT position, the signal is obtained from an external source through the TRIG IN front-panel connector.

2. In INT position, the signal is derived from the Y Amplifier.

3. In LINE position, the signal is tapped from one side of the 6.3 VAC heater circuit.

A choice of AC, LF REJECT, or DC coupling is provided by the Trigger Coupling switch. In the AC position, the trigger signal is applied to a high-pass filter consisting of C3002, C3003, and R3003 providing a low-frequency cutoff of 80 cycles. The cutoff frequency is raised to 15 Kc in the LF REJECT position and the high-pass filter now consists of C3003 and R3002. In the DC position, the high-pass filters are disconnected and the triggering signal is applied directly to the trigger amplifier. The RC network, R3004 and C3004, in series with the grid of V3001, serves to protect the input circuit from damage to excessive input voltage. Shunt capacitor C3004, preserves the high-frequency signal component.

b. Trigger Amplifier

The trigger amplifier V3001, is a cathode-coupled amplifier. Output is always taken from the B-Section plate (pin 6). For positive-going signals, connection is made to the grid of V3001B (pin 7), and for negative-going signals, connection is made to the grid of

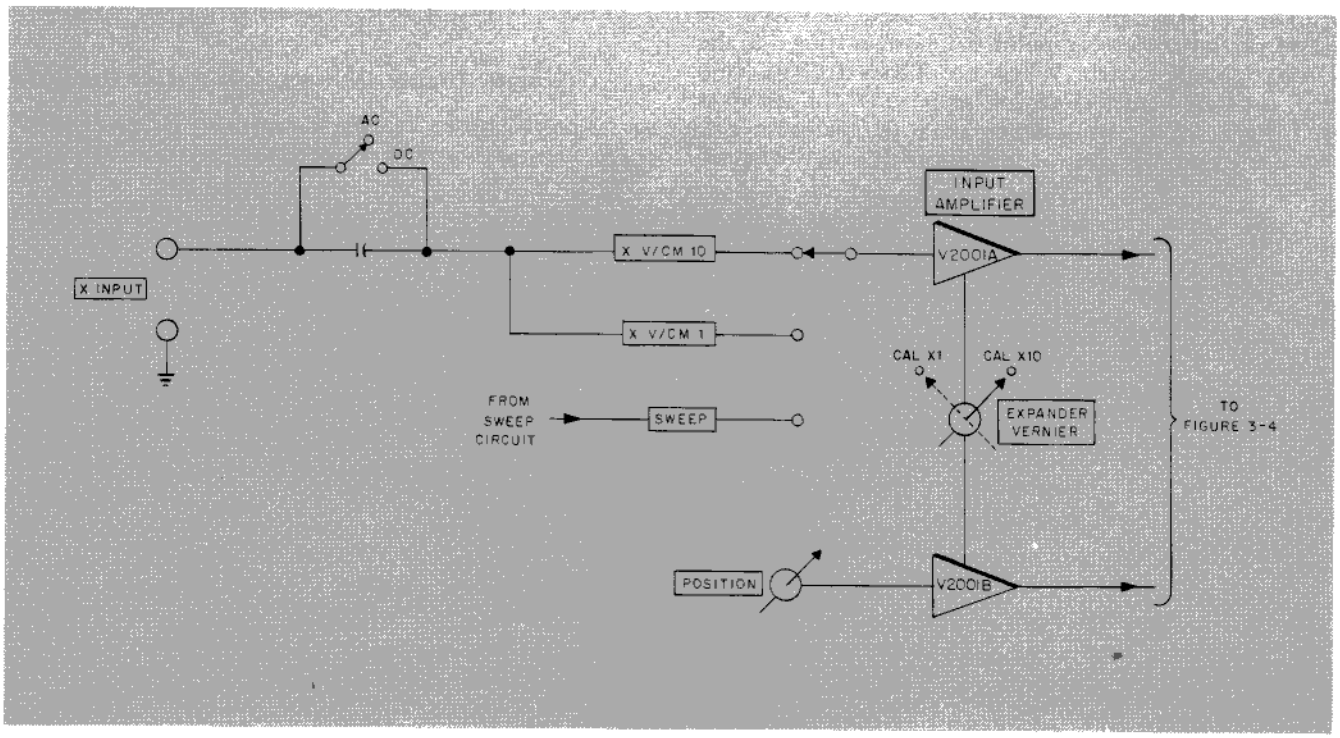


Figure 3-3. X Input Circuit, Simplified Functional Block Diagram

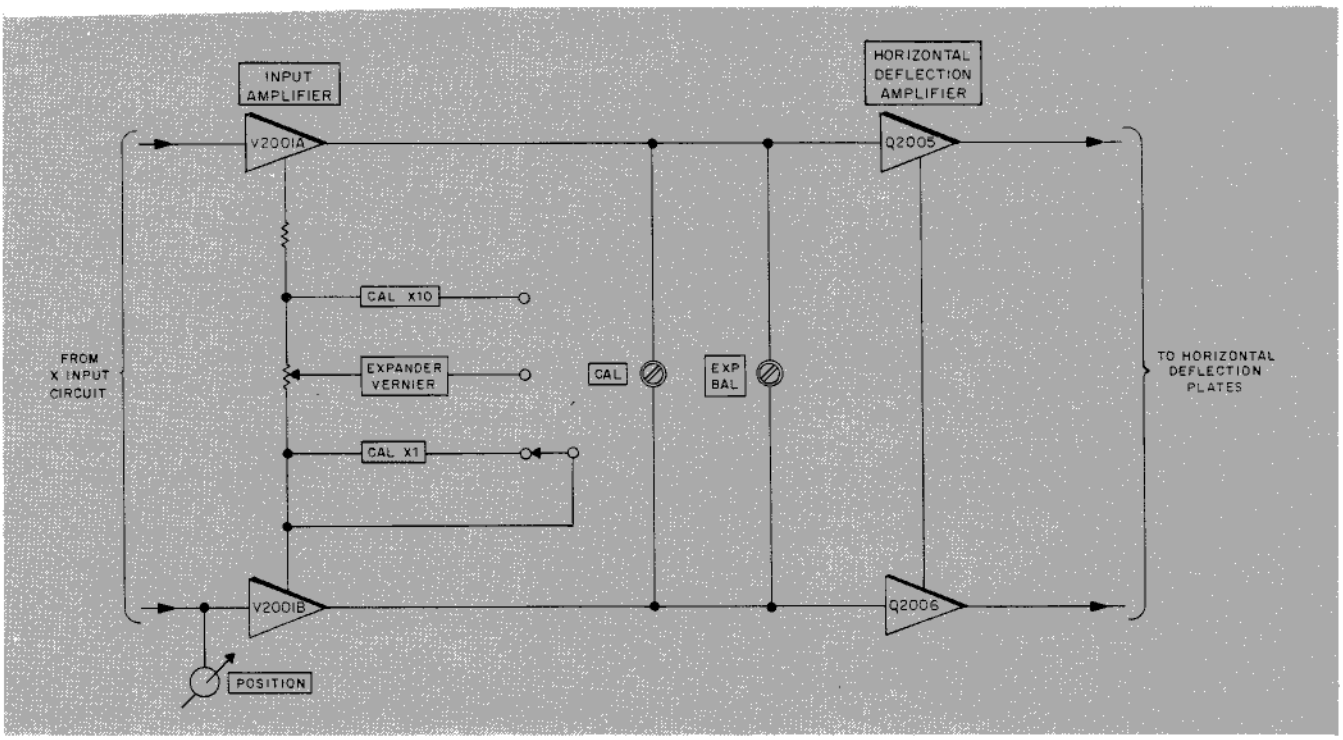


Figure 3-4. X Deflection Amplifier, Functional Block Diagram

V3001A (pin 2). In each case, the opposite grid is connected to a dc bias source, adjustable by means of the TRIG LEVEL control R3006.

The TRIG LEVEL control is used to select the level of the triggering point for both settings of the Trigger Slope switch. When the TRIG LEVEL control is rotated fully clockwise to AUTO, the sweep is self-triggered in the absence of a triggering signal. As you rotate the control away from the AUTO position, the automatic sweep feature will cease. Continued rotation of this control will permit the operator to adjust the triggering level of the pattern within the limits specified in the Technical Summary Table.

c. Schmitt Trigger Generator and Auto Triggering

The Schmitt Trigger Generator is essentially a regenerative signal level detector. It consists of a two-

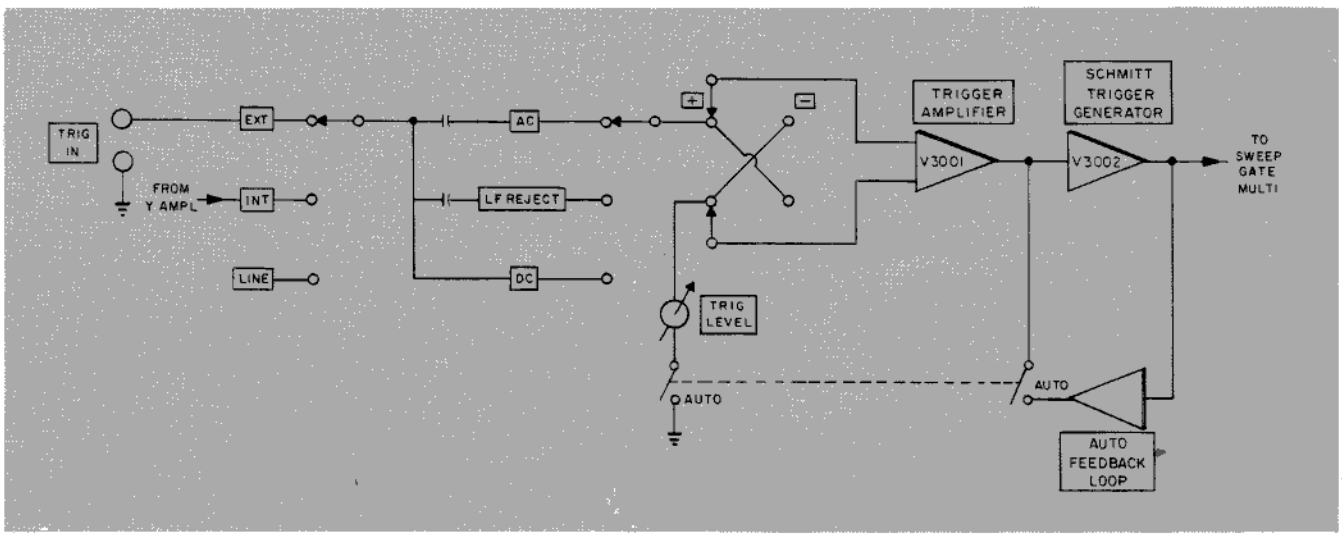


Figure 3-5. Trigger Circuit, Functional Block Diagram

stage amplifier V3002A and V3002B, having a dc plate-to-grid coupling from A to B amplifier and dc cathode-to-cathode coupling. The circuit has two stable states: the A side conducting, the B side at cutoff; the B side conducting, the A side at cutoff. The transition from one state to the other is abrupt, producing fast rise and fall times from each anode in the circuit.

The dc voltage applied to the grid of V3002A determines which state the circuit will be in. Assume operation as follows: V3002A is conducting and V3002B is at cutoff. V3002B will remain at cutoff until the amplitude of a positive-going signal applied to its grid reaches the threshold level of conduction. When this threshold level is exceeded, an abrupt transition from cutoff to full conduction will occur in V3002B. Simultaneously, V3002A is driven to cutoff and will stop conducting. V3002A and V3002B will revert to their original condition when the amplitude of the initiation signal falls slightly below the threshold level of conduction for V3002B.

In general, the threshold voltage is higher when moving the grid in a positive direction, and lower when moving the grid in the negative direction. The two different voltage levels are called the "upper and lower hysteresis limits" of the Schmitt Trigger Generator. The hysteresis offset basically relates to the input peak-to-peak voltage sensitivity of the trigger system.

The initial A-side grid level can be positioned anywhere inside or outside of the hysteresis area, thus establishing the input voltage required to change the state of V3002A. The steady state grid bias of V3002A is normally determined by the TRIG LEVEL control setting.

When the TRIG LEVEL control is set to AUTO, the trigger amplifier is ac coupled to the input grid of the Schmitt Trigger Generator through C3007, and the feedback resistor R3022 is connected between the grids of the Schmitt Trigger Generator. This causes V3002A and V3002B to flip back and forth yielding about 50 pulses per second in the AUTO position. Thus, a horizontal reference trace will appear on the screen even in the absence of an input signal.

3-5. SWEEP CIRCUIT (Figure 3-6)

a. Sweep Gate Multivibrator

The output from the Schmitt Trigger Generator is differentiated by C3009 and R3512 and applied to the grid of V3501B through turn-on diode CR3502.

The dc coupled bistable multivibrator V3501A and V3501B, initiates the formation of the sweep after receiving a negative trigger from the Schmitt Generator. Diode CR3502 and the lockout circuit hold off subsequent triggering signals until after the sweep and retrace are completed. In the quiescent state,

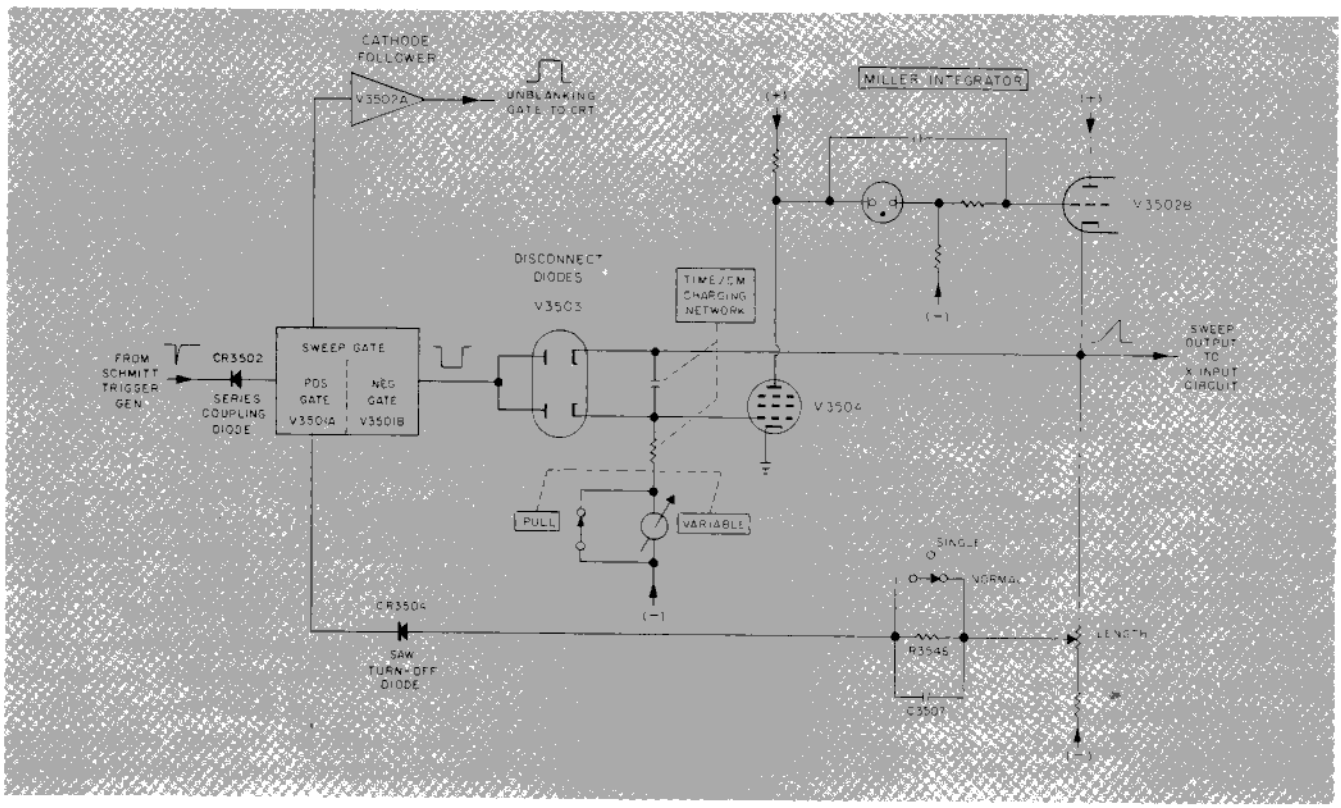


Figure 3-6. Sweep Generator, Simplified Diagram

V3501B is conducting and V3501A is at cutoff. V3501B forms a positive gate while V3501A forms a negative gate during the forward sweep interval.

CR3502 serves as a low capacitance coupling diode which couples the negative trigger from the Schmitt Generator to the sweep gate multivibrator which flips and initiates the sweep. CR3502 also serves as a high back-impedance diode to decouple the Trigger Generator from the sweep gate multivibrator. After the bistable multivibrator has been triggered, the sweep runs up. When the saw reaches full screen deflection, turnoff diode CR3504 conducts and resets the multivibrator V3501 which then clamps the saw. The sweep LENGTH potentiometer R3536 is adjusted for full screen sweep length display.

b. Saw Generation

The saw generator is of the Miller "run-up" type. The negative output developed at the plate of V3501A is applied to the plates of the disconnect diodes V3503A and V3503B. The anode voltages of these diodes are now below their cathodes, and the diodes no longer conduct. This action unlocks the integrator clamp and permits the selected sweep capacitor to charge linearly through the associated resistance network.

The grid of the Miller integrator moves negatively when the clamp is unlocked. The plate voltage of V3504 rises positively carrying the saw cathode-follower (V3502B) grid, cathode and timing capacitor in the same direction. A flow of current is required into the charging capacitor if the voltage across this capacitor is to change. The charging current must flow through the charging resistor. The time required to change the voltage across the charging capacitor determines the sweep time.

The positive voltage swing on the opposite side of the timing capacitor tends to prevent the grid side from swinging negatively. It also increases the voltage to which the timing capacitor is trying to charge. The net result is to *straighten out* the charging curve (sweep voltage) by maintaining a constant current flow in the capacitor.

Since the grid of V3504 remains at a constant potential within a small fraction of a volt, the current through the charging resistor remains constant and the sweep timing capacitor thus charges at a constant rate. The resulting linear sawtooth waveform is applied to the horizontal deflection system.

The EXPANDER VERNIER control provides a calibrated magnification of the sweep about screen center by factors 1 or 10. Any portion of the expanded display may be observed by adjusting the POSITION control.

When a Trigger Mode switch is set to SINGLE, the saw turn-off diode CR3504 is isolated from the LENGTH potentiometer by R3546 and C3507. Thus only a single trace will now sweep across the screen when the sweep is triggered. At the end of its travel, the beam will rest off screen because the sweep gate multivibrator is locked in this position. To reset or rearm the sweep, flip the Trigger Mode switch from SINGLE to NORMAL and back to SINGLE position. Refer to the Operating Instructions Section for application of this technique.

c. Sweep Length

The sweep length, or the total duration of the sweep for any given sweep rate is determined by the setting of the Sweep LENGTH adjustment R3536. A portion of the positive sawtooth voltage is fed back to the saw turnoff diode CR3504. If the Sweep LENGTH potentiometer is properly set, diode CR3504 will conduct when the positive-going excursion of the sawtooth has travelled 10.5 to 11 centimeters on the screen. This positive peak signal will then be conducted through diode CR3504 to the grid of V3502A. Upon receiving this positive pulse, the sweep gate multivibrator will revert rapidly to its original state with V3501B conducting, and V3501A at cutoff. The positive step from the plate of V3501 returns the disconnect diodes V3503A and V3503B, back to their conducting state thus discharging the timing capacitors. The Miller circuit now returns to its quiescent level and is ready for the next sweep cycle after the lockout time interval is completed.

d. Lockout Circuit

The lockout circuit prevents the sweep gate multivibrator from being triggered until the sweep retrace interval has reverted the saw to its quiescent base level. The sweep does not retrace in zero time since the clamping of the Miller integrator timing capacitor is accomplished by a diode switch circuit having a small impedance. The timing circuit discharge (saw retrace) takes longer than the flipping of the sweep gate multivibrator. Consequently, the trigger excitation pulses must be held off to prevent the formation of a new saw during the retrace interval. The sawtooth waveform must be permitted to retrace completely to its quiescent base which re-establishes the beam at the left-hand side of the CRT screen. This is accomplished by holding the cathode of the series-triggering diode CR3502 at a suitable positive voltage for a given period after the completion of the sweep.

During the forward sweep interval, a portion of the positive gate voltage is fed back through R3544 to charge the lockout capacitor through coupling diode CR3501. When the saw reaches its predetermined full screen length, the sweep gate multivibrator flips and clamps the Miller integrator which then causes the

sweep to retrace. During the return-trace interval, diode CR3501 is cut off and the lockout capacitor is discharged through R3516. The sweep gate multivibrator will not retrigger until the preselected lockout timing capacitor is chosen to give lockout beyond the time that the sweep has returned to rest at its initial starting point. The duration of the lockout interval is determined by the sweep charging time constant and the Miller integrator clamp. Consequently, the TIME/CM switch must also change the lockout circuit hold-off timing capacity. This technique prevents additional triggers from initiating the sweep gate multivibrator until the sweep retrace interval is completed and the saw reverts to its quiescent state at the left-hand side of the screen.

The trigger coupling diode CR3502 prevents triggers from disturbing the sweep gate multivibrator during all of the sweep-forward interval. The lockout circuitry prevents retriggering during the retrace interval.

e. Unblanking

The cathode-ray tube employed in this oscilloscope has two additional beam deflecting plates which cut off the electron beam independently of the control grid. Beam control pulses (trace brightening and retrace blanking pulses) can easily be dc coupled since these beam deflection plates are electrically close to ground. In conventional circuits these pulses must be coupled to the control grid which is operated at high potential.

The extra beam deflection plates are controlled by the sweep gate multivibrator V3501. A positive gate is developed at the plate of V3501B and is coincident with the sweep forward time. This pulse is applied to the beam deflection plate of the cathode-ray tube through cathode follower V3502A. Hence the display is visible only during the forward sweep interval and is blanked during the retrace and lockout interval.

When the TIME/CM switch is set to X V/CM, one side of the sweep gate multivibrator is ungrounded thus disabling the sweep circuit and turning on the beam. The horizontal deflection amplifier may now be set up to display external signals.

3-6. LOW-VOLTAGE POWER SUPPLY

a. Power Transformer

Plate and heater power for this instrument is provided by a single power transformer T4001. The primary is wound with two equal 115-volt windings that can be connected either in parallel for 115-volt operation, or in series for 230-volt operation. See Technical Summary Table for additional data found in Section 1.

b. Regulated Supplies

Regulated supplies are provided with outputs as follows:

+160 volts, +57 volts, and −50 volts

All of these regulated supplies are of the constant-output voltage series-passing type. The basic reference for all of the regulated supplies is the fixed drop across V4004. This gas diode V4004, maintains a constant voltage drop of about 85 volts across itself within a broad current range.

Operation of the other low-voltage regulated supplies is identical, so only the +160-volt supply is described. CR4001 to CR4004 are connected in a conventional bridge rectifier circuit. The rectified output is capacitively filtered by C4001. Resistor R4000 shunts the filter capacitor as a safety measure to leak off the charge when the instrument is turned off.

The filtered rectified output is applied to V4001 series-passing tube whose voltage drop is adjusted by the feedback voltage from R4008R through the dc amplifier Q4001. Assume the output voltage tends to decrease. This will lower the base voltage of the error detector amplifier Q4001. The resulting increase in voltage at the collector of Q4001 is applied to the control grid of the series-passing tube. The resultant voltage change in the series-passing tube V4001 is such as to return the output voltage to its proper value.

c. Voltage Calibrator

The power-line frequency voltage from T4001 is applied to the base of voltage calibrator Q4007 through limiting resistor R4051. Negative and positive excursions will drive the transistor into and out of conduction at the line-frequency rate. The resulting square wave at the collector of Q4007 is applied to a voltage divider. The attenuated output is coupled to the vertical amplifier when the Y VOLTS/CM switch is set to CAL.

3-7. CRT CIRCUIT

a. CRT Beam Control Circuits

The INTENSITY control R4509, part of the negative high-voltage divider, is used to vary the cathode-ray tube grid voltage to adjust the CRT cathode current. The FOCUS control R4503, varies the voltage at the focusing anode to set the second cross-over point of the electron beam right at the screen of the cathode-ray tube. The ASTIGmatism control R4523 is provided to vary the voltage at the astigmatism anode to optimize the spot shape in both axes.

b. High-Voltage Power Supply

Accelerating voltages for the cathode-ray tube are obtained by rectifying a 60 Kc sine wave voltage

produced by a vacuum-tube oscillator. V4501 is the oscillator tube connected as a Hartley oscillator with the primary of transformer T4501 as the tapped inductor and C4511 as the timing capacitor.

The output of the oscillator is stepped up by T4501 and applied to a conventional half-wave rectifier. The rectified output is applied to the cathode-ray tube after being filtered to remove virtually all of the ripple content.

Regulation of the high-voltage negative supply is accomplished by sampling a portion of the rectified output and applying a correction signal back through V4502 to the screen grid of V4501. This action changes the amplitude of oscillations of V4501 and T4501 in such a manner as to restore the high voltage output to its preset level. Potentiometer R4505, HV ADJ, is provided to preset the output of the high-voltage supply to its proper level.

SECTION 4
PERFORMANCE ASSURANCE TEST

4-1. MAINTENANCE CHECK TO ASSURE PERFORMANCE

The test described in the paragraphs to follow should be performed by Instrument Test Departments and Maintenance Laboratories to certify proper performance of the instrument. These tests are divided into sections for simplification and to assist those test groups where complete checking is not mandatory, or where all test equipment is not available. Refer to Section 5, paragraph 5-6 for list of test equipment required.

NOTE

If this oscilloscope is checked by a receiving inspection laboratory, the tests outlined below are recommended to certify performance. This oscilloscope has been thoroughly tested and aged at the factory. Nevertheless, rough shipment, extreme environments, or long idle periods may necessitate minor adjustments of the controls. Hence, it is suggested that the certifying engineer try the recommended adjustments not only for recentering the controls, but also to ascertain their range and to familiarize himself with this precision instrument. If, after performing all the tests outlined below, the instrument will not perform to specification, the assistance of the local Fairchild Field Engineering representative should be requested.

4-2. INITIAL SETUP OF TYPE 701 (Figure 4-1)

If the controls are set exactly as shown and performed in the sequence indicated in Figure 4-1, three cycles of the calibrator signal (60-cycle line) will be displayed on screen. The procedure just given is a good, over-all check of the Type 701 Oscilloscope.

4-3. CHECKING THE POWER SUPPLY

1. Check the line fuse located on the front panel for proper value (2 amperes).
2. Open the covers and carefully inspect the instrument; correct any visible defects.
3. Apply power to the instrument through a variable voltage source (Variac, or an equivalent). Set the line voltage to 115 volts. (Double this value for 230-volt operation.)
4. Set up the oscilloscope to obtain three cycles of the calibrator signal.
5. Allow 30 to 60 minutes for warmup before making any final adjustments.
6. Lower the line voltage until the display starts to drift or become erratic. The line voltage must be less than 105 volts at 60 cycles (210 volts for 230-volt operation). If instability is noted before the lower limit of the line voltage is reached, check operation of the low-voltage regulated power supplies as outlined in Section 5 of this Instruction Manual.
7. Raise the line voltage to 125 volts (250 volts for 230-volt operation). The display should remain stable and must not be erratic. If instability is noted before the upper limit of the line voltage is reached, check operation of the low-voltage power supplies.
8. Reset the line voltage to 115 volts (230 volts for 230-volt operation).

4-4. CHECKING Y ATTENUATOR

1. Connect the output of a Ballantine Type 420 Calibrator, or equivalent, to Y INPUT connector on the Type 701 Oscilloscope.
2. Refer to accompanying Amplitude Check Calibration Chart for additional data.

AMPLITUDE CHECK CALIBRATION CHART

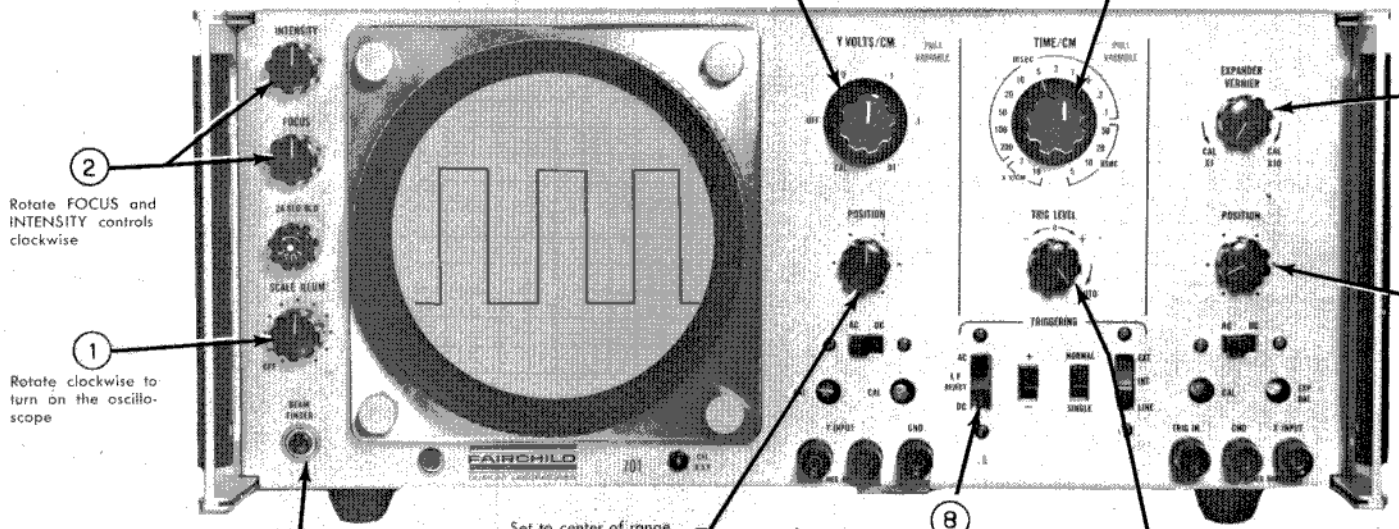
Y VOLTS/CM Setting	Generator Output Voltage	CM of Deflection ±3%
10V	10V	1
1V	5V	5
0.1V	0.5V	5
0.01V	5 mV	5

4-5. CHECKING SWEEP CALIBRATION

1. Connect a Fairchild Type 781 Time-Mark Generator to the Y INPUT connector of the oscilloscope through a properly terminated cable.
2. Set EXPANDER VERNIER switch to CAL X1.
3. Sweep accuracy is checked by counting the positive peaks in the centered 8-centimeter portion of the CRT scale. Make sure the PULL VARIABLE knob is pushed in and refer to the accompanying Sweep

To obtain the calibrator display, set the controls exactly as shown and perform the numbered steps in sequence.

Use the same procedure when difficulty is experienced when obtaining a display. This will eliminate "cockpit" troubles due to misalignment of controls.


Push in red knob and set outer knob (Y VOLTS/CM) to CAL
3
Push in red knob and set outer knob (TIME/CM) to 5 mSEC
4
Set to CAL X1 (click is heard)
5
2
Rotate FOCUS and INTENSITY controls clockwise
1
Rotate clockwise to turn on the oscilloscope
6
Set to center of range. (Knob positions trace horizontally)
Set to center of range. (Knob positions trace vertically)
9
8
Set TRIGGERING switches to AC, +, NORMAL, LINE
7
Rotate clockwise to AUTO until switch is actuated (click is heard)
10
If no trace appears, depress and hold the BEAM FINDER button and readjust POSITION controls (see 6 and 9) to center the display
Readjust INTENSITY & FOCUS controls (see 2) for a sharp pattern
INTENSITY
FOCUS
SCALE ILLUM
BEAM FINDER
Y VOLTS/CM
TIME/CM
EXPANDER VERNIER
POSITION
TRIG LEVEL
TRIGGERING
FAIRCHILD
701

NOTE

Y BAL control must be properly adjusted to obtain an on-screen trace. See paragraph 2-2.

Figure 4-1. Initial Setup of Type 701 Oscilloscope

Check Calibration Chart for additional data. All measurements indicated in this chart should fall within ±2 mm of the 9-centimeter marking. (8.8 cm to 9.2 cm.)

SWEEP CHECK CALIBRATION CHART

TIME-MARK GEN set to	TIME/CM set to	NUMBER OF POSITIVE PULSES*
5 μsec marker	5 μsec	9 timing markers
10 μsec marker	10 μsec	9 timing markers
10 μsec marker	20 μsec	17 timing markers
50 μsec marker	50 μsec	9 timing markers
100 μsec marker	0.1 msec	9 timing markers
100 μsec marker	0.2 msec	17 timing markers
500 μsec marker	0.5 msec	9 timing markers
1 msec marker	1 msec	9 timing markers
1 msec marker	2 msec	17 timing markers
5 msec marker	5 msec	9 timing markers
10 msec marker	10 msec	9 timing markers
10 msec marker	20 msec	17 timing markers
50 msec marker	50 msec	9 timing markers
100 msec marker	0.1 sec	9 timing markers
100 msec marker	0.2 sec	17 timing markers

* Centered 8-cm portion of scale (8.8 cm to 9.2 cm)

4-6. CHECKING BANDWIDTH OF Y AMPLIFIER

1. Use the test setup depicted in Figure 4-2.
2. Set Y VOLTS/CM switch to 0.01 and push in the PULL VARIABLE control.

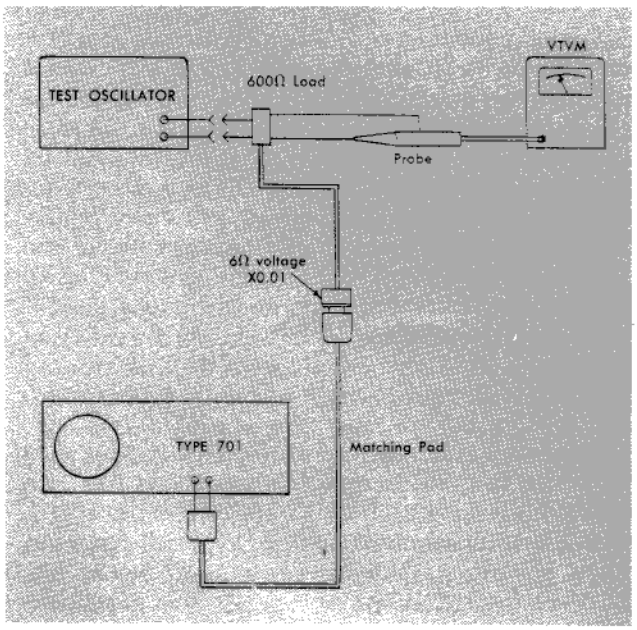


Figure 4-2. Test Setup for Bandwidth Measurement

3. Set the Hewlett-Packard Model 650A Signal Generator for 1 KC and adjust the generator for 10 cm of vertical deflection on the screen of the oscilloscope.
4. Note the reading on the VTVM.
5. Switch the test frequency to 500 KC and adjust output of the generator to give the same reading on the VTVM as noted in step 4. The vertical deflection amplitude observed on the screen of the oscilloscope should not be less than 6.5 cm nor more than 7.9 cm.

4-7. CHECKING RISE TIME OF Y AMPLIFIER

1. Preset front-panel controls as follows:

Control	Setting
Y VOLTS/CM	0.01
TIME/CM	10 μSEC
PULL VARIABLE	both knobs pushed in
EXPANDER VERNIER	CAL X10

2. Apply the output from a square wave generator properly terminated to Y INPUT.
3. Set generator for 100 Kc and adjust its output for 10 cm of vertical deflection on the screen of the oscilloscope.
4. Measure the rise time. It should be from 0.7 cm to 0.8 cm.

4-8. CHECKING BANDWIDTH OF X AMPLIFIER

1. Use the test setup depicted in Figure 4-2 except that the X INPUT is connected directly to the 600-ohm load instead of the 6-ohm load.
2. Preset front-panel controls as follows:

Control	Setting
Y VOLTS/CM	OFF
TIME/CM	X V/CM 1
EXPANDER VERNIER	CAL X1

3. Set the Hewlett-Packard Model 650A Signal Generator for 1 KC and adjust the generator for 10 cm of horizontal deflection on the screen of the oscilloscope.
4. Note the reading on the VTVM.
5. Switch the test frequency to 350 KC and adjust output of the generator to give the same reading as the VTVM as noted in step 4. The horizontal deflection amplitude observed on the screen of the oscilloscope should not be less than 6.5 cm nor more than 7.9 cm.

SECTION 5
MAINTENANCE AND RECALIBRATION

5-1. INTRODUCTION

This section of the manual contains service information and procedures for internal adjustments.

WARNING

WHEN THE PANELS ARE REMOVED FROM THE INSTRUMENT FOR SERVICING, EXERCISE CAUTION WHILE THE POWER IS ON. The lower-voltage busses are potentially more dangerous than the cathode-ray tube potential because of the high-current capabilities and large filter capacitors employed in these supplies. When you reach into the instrument with one hand while it is turned on, do not grasp the metal frame with the other hand. If possible, stand on an insulated floor and use insulated tools. It is advisable to ground the third lead in the power cord whenever the instrument is in use.

To gain access to the chassis for service, remove the top and bottom panels. This will expose all of the transistors, tubes and service adjustments for normal maintenance.

5-2. REMOVAL AND REPLACEMENT OF PARTS

If it is necessary to order a replacement component from the factory, always give the Type Number and Serial Number of the instrument. Before ordering parts for in-warranty replacement or purchasing them for out-of-warranty replacement, be sure to consult the Parts List in this manual. The Parts List gives the values, tolerances, ratings, and the factory part number for all electrical components used in the instrument. This will help to expedite service.

Since your instrument left the factory, some of the parts may have been superseded by improved components. In such cases, the part numbers of these new components will not be listed in your Parts List. However, if you order a part from the factory and it has been superseded by an improved component, the new part will be shipped in place of the part ordered.

It is the aim of the Fairchild organization to make available the most reliable commercial oscilloscopes within the state of the art and to provide services which will help the user to rapidly restore any of our equipment to its specified performance. Your local Field representative maintains a limited number of spare parts. Also, the factory may be asked to air-ship replacement parts on a rush basis.

The procedure for replacing most parts in this instrument is obvious, therefore specific instructions for their removal are not required.

Note: Be sure and replace the beryllium oxide insulating washers (they serve as heat sinks) on the transistors that require them. Always grease these heat sinks with Dow Corning silicon grease for optimum heat transfer.

5-3. CATHODE-RAY TUBE REPLACEMENT

CAUTION

THE CATHODE-RAY TUBE SHOULD BE HANDLED WITH GREAT CARE TO PREVENT BREAKAGE AND/OR SERIOUS PERSONAL INJURY FROM FLYING GLASS.

To remove the cathode-ray tube, first remove the top and rear covers. Remove the bezel and loosen the tube clamp at the base of the CRT. Pull the cathode-ray tube straight out through the front panel. Install the new cathode-ray tube by the reverse of the foregoing procedure. Refer to paragraph 5-8 for CRT internal or external graticule adjustment.

After the cathode-ray tube has been replaced, it may be necessary to recalibrate. Special attention should be given to recalibration of the time base sweep rates and to the amplifier sensitivities.

5-4. SERVICING HINTS

Although this is a complex electronic instrument, trouble may be localized to the following basic circuits:

1. Low-voltage Power Supply
2. High-voltage Power Supply
3. Cathode-ray Tube Circuit
4. Vertical Deflection Amplifier
5. Trigger Circuit
6. Time Base Circuit
7. Horizontal Deflection Amplifier

Whenever trouble occurs in this instrument, first try to localize it to one of these basic circuits.

There is no simple way of locating troubles. An understanding of the functions of the circuits is the best help (see Circuit Description, Section 3). With an understanding of the circuits, you will be able to make a reasonable assumption at the general source of troubles from their symptoms.

As an aid in trouble-shooting this unit, refer to the simplified functional block diagrams given in Section 3, and of the schematics located at the rear of this Instruction Manual.

To keep electronic units operating at top performance, it is desirable to check the equipment at regular intervals. How often it is checked will depend on the installation and the conditions of operation. In general, portable units moved about constantly will require more frequent service than units fastened down permanently. For these regular checks, clean all dust and dirt from the unit using a light air blast or soft brush.

In the event of improper equipment performance, the following suggestions are recommended:

1. If the instrument fails to operate, including the pilot light, check the source of power and determine that the power cord is firmly in place. Then check all fuses. A thermal cutout switch is incorporated in this unit. If the instrument has been working but has just stopped, it may have overheated and tripped the thermal cutout switch. The thermal cutout switch will reset itself when the interior temperature of the instrument drops to a safe value. Possible causes of overheating are restriction of air circulation and high ambient temperature.

2. If the line voltage is within the specified limits, and one of the regulated power supply output voltages is not correct, check that particular regulator circuit.

Note: Always check the power supplies in the following order: +160V, +57V, −50V and −2400V

3. If there is nothing on the screen, try to set up the oscilloscope as depicted in Figure 2-5 entitled "Initial Setup of Type 701 Oscilloscope" in Section 2 of this manual.

4. Localizing the trouble is made easier by use of an oscilloscope to check waveforms. Use a high-impedance probe while trouble shooting.

5. Maintain a high quality of workmanship. Use a clean bench and soldering iron; keep solder joints smooth and bright; do not overheat any component while soldering. Use heat sinks while soldering semiconductors. The use of a 30-watt iron such as a Hexacon Type 26S is recommended.

6. When using the accessory probes or adapters, be sure the trouble is *not* originating in the accessory before suspecting the oscilloscope itself.

7. Once the defective stage has been localized, the component or components causing the trouble can be located by tube and component substitution or by voltage measurements. Key voltage measurements are shown on the over-all schematics at the rear of this manual.

8. Sometimes the aftermath of tube or transistor failure yields charred resistors or over-stressed capacitors. A visual inspection will usually expose the damaged component requiring replacement.

9. Identification of electron tubes, semiconductors and service adjustments are shown in photographs in this Section of the Instruction Manual.

5-5. PREVENTIVE MAINTENANCE

This unit is a stable instrument that will provide many hours of trouble-free operation. However, to insure the reliability of measurements, we suggest that you recalibrate the instruments after each 500 hours of operation or every six months if used intermittently. Also, the calibration of a unit should always be fully checked and adjusted after the repair or replacement of any component in the unit. The complete adjustment procedure for this instrument is given in this section of the Instruction Manual. The internal calibrator or a more precise standard may be employed to set the front-panel screwdriver CAL controls.

Note: The regulated power supplies should always be checked before calibrating any part of the instrument.

5-6. TEST EQUIPMENT REQUIRED FOR SERVICE ADJUSTMENTS

a. Introduction

The adjustments outlined in the following paragraphs are based on the test procedure followed at the factory.

Normally only periodic adjustment of the CAL and BALance controls will be necessary. The procedure outlined in this manual should be followed. The attenuators are factory aligned and should not be touched unless there is a positive indication that they require adjustment.

All adjustments should be made at mid-line voltage, 115V/230V ±2%.

b. Test Equipment Required (Equivalent may be substituted)

Equipment	Description
Volt-ohmmeter	Simpson Model 260 20,000 ohms/volt sensitivity
Square Wave Generator	Fairchild Type 791
Time-Mark Generator	Fairchild Type 781
Standard Amplitude Calibrator	Ballantine Type 420
High Voltage Meter	Sensitive Research Model DCH-1
Signal Generator	Hewlett-Packard Type 650A with 600-ohm termination
Autotransformer	Powerstat, Variac; capable of varying line voltage of the instrument over a range from 100 volts to 130 volts

Equipment	Description
AC Voltmeter	Weston Model 433
Potentiometric Voltmeter	John Fluke Model 801B; 0.1 to 500 volts
Alignment Tool	Insulated screwdriver (from Type 7013 Tool Kit)
2592-B	Shielded adapter connector; scope binding post to BNC
4285	50-ohm, 2-watt termination
4290	10:1 Passive Attenuator Probe
7012	Input Capacitance Standardizer
7082	42-inch coaxial jumper cable with BNC connectors at either end
7083	42-inch coaxial jumper cable with BNC connector at one end and alligator clip at the other end

5-7. ADJUSTING THE LV AND HV POWER SUPPLIES

Connect the autotransformer to a suitable power source and connect the oscilloscope output to this transformer. Turn on the instrument and set the output for the nominal operating voltage of the oscilloscope using the Weston Model 433 AC Voltmeter (115V for 115-volt operation, or 230V for 230-volt operation). Allow 30 to 60 minutes of warmup time before making any adjustments. Preset the front-panel controls as indicated.

Control	Setting
Y VOLTS/CM	CAL
TIME/CM	5 mSEC
TRIG LEVEL	AUTO
EXPANDER VERNIER	CAL X1
TRIGGERING	AC, +, NORMAL, INT
PULL VARIABLE	Both knobs pushed in

Use a John Fluke Voltmeter and adjust or check the supplies in the sequence listed.

1. Set the +57V ADJ (R4008F) to center of its range.
2. Adjust R4008R for +160 volts.
3. Adjust R4008F for +57 volts.
4. Check −50V supply; (−49.2V to −50.8V).
5. If the −50V supply is more negative than −50.8 volts, connect R4016 to +57V supply (white-red lead).
6. If the −50V supply is less negative than −49.2 volts, connect R4016 to −50V supply (white lead). In each case readjust R4008R (+160V ADJ).
7. Adjust HV ADJ potentiometer R4505, for −2400 volts at V4504, pin 2. Use *care* and *safety leads* while making this adjustment.

CAUTION

Always use insulated tools while working or making adjustments on the unit when power is on. The transistors in the oscilloscope may be damaged if over-voltaged by accidental grounding of one or more elements. Exercise caution and turn off power when making repairs.

5-8. CRT ADJUSTMENTS

a. Astigmatism (R4523)

1. Set up the oscilloscope for normal operation using the calibration signal.
2. Adjust ASTIG potentiometer, R4523 simultaneously with the FOCUS control until optimized focusing of the pattern is obtained in both the horizontal and vertical plane.
3. Maintain normal intensity while making these adjustments.

b. Graticule External to CRT

To align the trace to the graticule, proceed as follows:

1. Use AUTOmatic sweep with no signal applied to the vertical channel.
2. Loosen CRT clamp.
3. Center the trace and rotate CRT so that the trace is parallel to the center line of the graticule.
4. Tighten CRT clamp.

c. Graticule Internal to CRT (R4523R)

1. Where the graticule is internal to the CRT, align the tube so that the horizontal center line is perpendicular to the left side of the frame. Clamp the CRT.
2. Set up instrument for automatic sweep with no signal applied to the vertical channel.
3. Adjust R4523R (concentric control as part of the ASTIG assembly) until the trace is parallel to the center line of the graticule.

5-9. X (R2029) AND Y (R1059) OUTPUT LEVEL ADJUSTMENTS

The X and Y OUTPUT LEVEL ADJ potentiometers are provided to set the X deflection plate average potential equal to the Y deflection plate average potential.

1. Set TIME/CM switch to X V/CM; adjust for a dim spot and position it to screen center.
2. Temporarily short the collectors of Q2005 and Q2006 together (located in the X amplifier).

3. Connect the John Fluke Voltmeter between the now common collectors to ground.

4. Adjust the X OUTPUT LEVEL ADJ potentiometer R2029 for 115 volts. A range of 116V to 120V may be permitted to eliminate on-screen amplifier cutoff.

5. Disconnect the meter and the X deflection plate short.

6. Temporarily short the collectors of Q1005 and Q1006 together (located in the Y amplifier).

7. Repeat Steps 3, 4, and 5 except adjust Y OUTPUT LEVEL ADJ potentiometer R1059 for 119 volts. A range of 117V to 121V may be permitted to eliminate on-screen amplifier cutoff.

5-10. Y BALANCE ADJUSTMENT

When the BAL control is properly adjusted, there will be no depositioning of the trace when the PULL VARIABLE control is used. To adjust, proceed as follows:

1. Set Y VOLTS/CM switch to OFF and pull out the VARIABLE control knob and turn it fully counterclockwise.

2. Center the trace with the POSITION controls. If necessary, use the BEAM FINDER push button to speedily locate the display.

3. Rotate Y PULL VARIABLE control fully clockwise.

4. Adjust the BAL control to recenter the trace.

5. Repeat this procedure until there is no depositioning of the trace while rocking the VARIABLE control back and forth.

5-11. OUTPUT PEAKING COMPENSATION TRIMMER (C1016)

Trimmer capacitor C1016 is factory aligned and should not be touched unless there is positive indication that it requires adjustment. If adjustment is necessary, follow the steps as outlined.

1. Set Y VOLTS/CM switch to 0.01 and TIME/CM switch to 20 μsec.

2. Apply the output from a square wave generator set to 25 Kc to Y INPUT connector.

3. Start with C1016 set for maximum capacity (fully clockwise).

4. With an insulated alignment tool, tune C1016 (ccw) to a point where overpeaking is eliminated and some slight rounding of the square wave is visible.

5-12. NORMALIZING Y AMPLIFIER SENSITIVITY AND CERTIFYING THE CALIBRATOR

The X and Y CAL front-panel screwdriver controls are employed to calibrate the amplifier sensitivity.

To properly normalize the gain of this instrument, proceed as follows:

1. Preset front-panel controls as indicated:

Control	Setting
EXPANDER VERNIER	CAL X1
Y VOLTS/CM	0.01
TIME/CM	5 mSEC
PULL VARIABLE	Both knobs pushed in

2. Apply a 50 millivolt peak-to-peak signal from the Ballantine Type 420 Calibrator to Y INPUT.

3. Adjust the Y CAL control for precisely 5 cm of vertical deflection. The vertical deflection system is now normalized to the external standard.

4. Set Y VOLTS/CM switch to CAL. The internal calibrator signal should be displayed on the screen with an amplitude of 4.8 cm to 5.1 cm. If these limits are not met, certify the Ballantine Calibrator to a primary standard.

5. Repeat Steps 1 through 4. If a lack of correlation is still manifested, check the regulated power supplies, Q4007, and the precision resistors in the calibrator circuitry.

5-13. PHASE SHIFT ADJUSTMENT (C2012)

A phase shift trimmer capacitor C2012 is added across the output of the horizontal deflection amplifier and is adjusted when necessary for optimum phase differential between the X and Y amplifiers in a particular application. Normally, C2012 is set to minimum and does not require recalibration since its adjustment applies only to the X-Y comparison measurement on display.

If phase shift adjustment is required for certification, proceed as follows:

1. Apply a 100 Kc sine wave signal from a properly terminated generator to both the X and Y INPUT connectors.

2. Set TIME/CM switch to X V/CM 1 and Y VOLTS/CM switch to 0.01.

3. Adjust sine wave generator for 8 centimeters of deflection.

4. Adjust C2012 for a single diagonal line.

5-14. Y INPUT CAPACITANCE ADJUSTMENT (C1004)

1. Set Y VOLTS/CM switch to 0.01.

2. Connect the output of a properly terminated square wave generator through the Type 7012 Input Capacitance Standardizer to Y INPUT. See Figure 5-1.

3. Set square wave generator to 5 Kc and adjust the Type 7012 for best square wave response. See Figure 5-2.

4. Turn Y VOLTS/CM switch to 0.01.

5. Adjust capacitor C1004 for best square wave response.

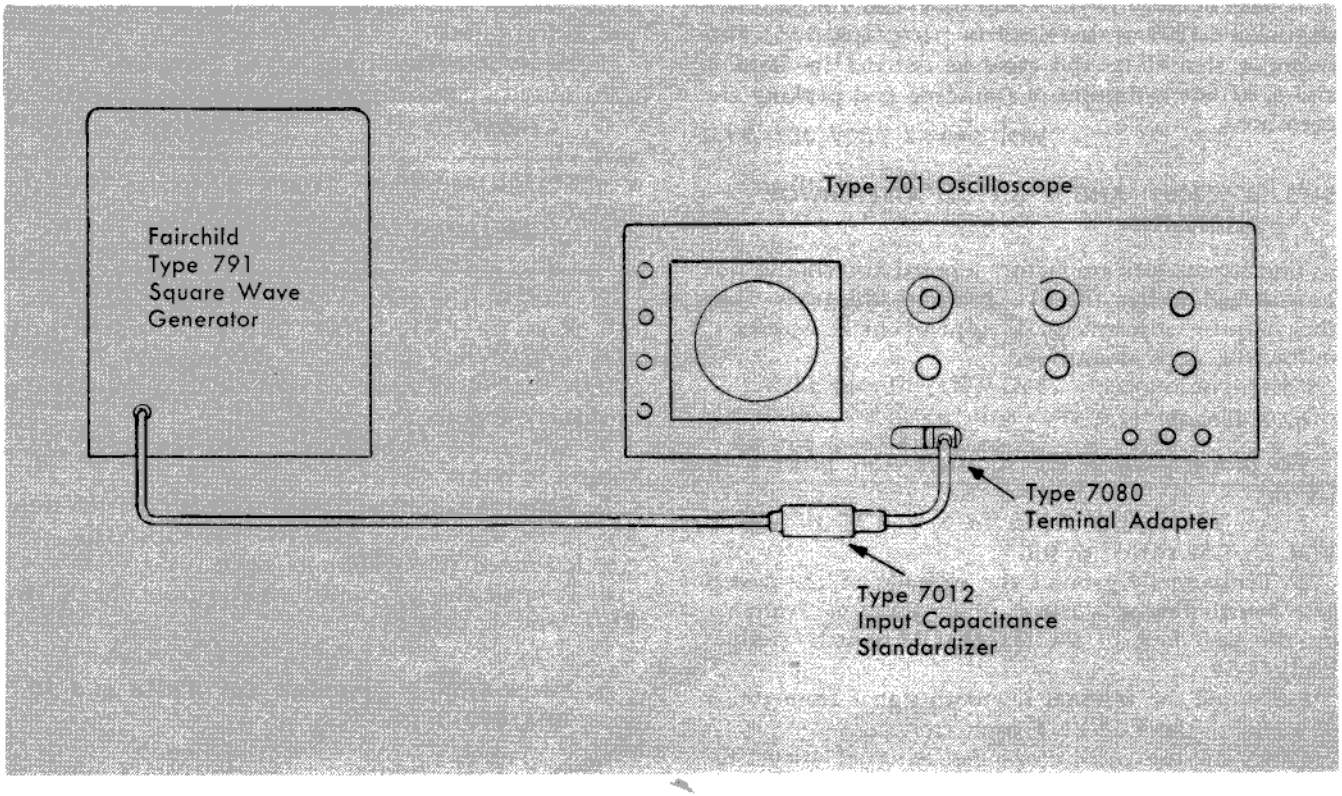


Figure 5-1. Test Setup for Adjusting Input Capacitance

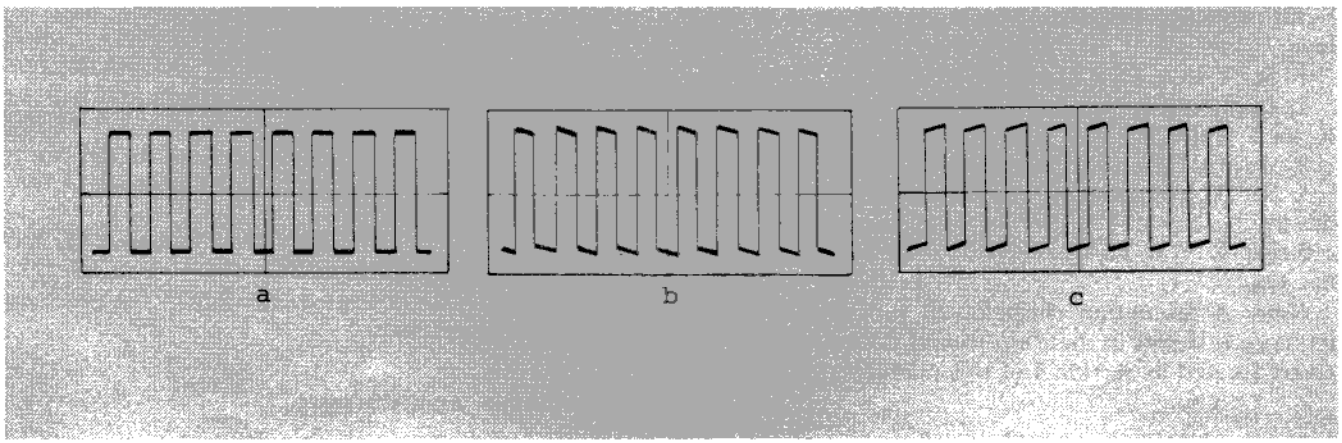


Figure 5-2. Standardizing the Input Capacitance

a: Proper adjustment
b, c: Improper adjustments

6. Check the 0.1V/Cm and 1 V/Cm ranges after adjusting C1102 as described in paragraph 5-15. The response should be the same as derived in Steps 4 and 5. Minor variations of rounding and peaking are permitted.

5-15. X (C2002) AND Y (C1102) ATTENUATOR ALIGNMENT

The attenuators are factory aligned and should not be touched unless there is positive indication that they require adjustment. If adjustment is necessary, follow the steps as outlined.

a. X Circuit

To properly align the X attenuator, proceed as follows:

1. Set TIME/CM switch to X V/CM 10 and Y VOLTS/CM switch to 0.1.
2. Temporarily ground the cathode of the sweep gate multivibrator V3501-8. This point is available on the last deck of the TIME/CM switch (yellow lead).
3. Couple the internal sawtooth signal from pin 3 of V3502 to the Y INPUT connector.
4. Set up the oscilloscope for external triggering and connect the output from a square wave generator to the X INPUT connector through a Type 4285 50-ohm termination and a Type 2592-B Terminal Adapter.
5. Set square wave generator for 10 Kc and adjust C2002 for best flat top. See Figure 5-2. To obtain the properly orientated waveform display for the X circuit, rotate Figure 5-2 90°.
6. Remove temporary ground set up in Step 2.

b. Y Circuit

To properly align the Y attenuator, proceed as follows:

1. Set Y VOLTS/CM switch to 0.1.
2. Connect the square wave generator set for 2.5 Kc to Y INPUT.
3. Adjust C1102 for best flat top.
4. Set Y VOLTS/CM switch to 1 and check for flat top.
5. Set X VOLTS/CM switch to 10 and check for flat top.

Note: A tabulation check of all ranges of the attenuator is shown in the *Amplitude Check Calibration Chart* located in Section 4 of this manual.

5-16. X AMPLIFIER ADJUSTMENTS

a. Expansion Balance (R2021)

When this front-panel screwdriver control is properly adjusted, the display on screen will expand equally about screen center for either the internal time base or externally applied signals. To adjust, proceed as follows:

1. Preset front-panel controls as indicated:

Control	Setting
Y VOLTS/CM	CAL
TIME/CM	X V/CM 10
EXPANDER VERNIER	CAL X10

2. Temporarily ground the X INPUT binding post.
3. Rock the EXPANDER VERNIER control back and forth several times while adjusting the X POSITION control to locate a point on screen where the X display appears to be balanced.
4. Adjust the front-panel screwdriver EXP BAL control to center the trace.
5. Repeat Steps 3 and 4 until there is no depositioning of the trace as the EXPANDER VERNIER control is rotated throughout its range.
6. Remove the temporary ground from the X INPUT binding post.

b. Normalizing X Amplifier (Cal, R2016 and 10:1 ADJ, R2013)

The X CAL front-panel screwdriver control is employed to calibrate the X amplifier sensitivity.

To properly normalize the gain of this instrument, proceed as follows:

1. Preset front-panel controls as indicated:

Control	Setting
TIME/CM	5 mSEC
EXPANDER VERNIER	CAL X10
PULL VARIABLE	Both knobs pushed in
Y VOLTS/CM	0.1V

2. Connect the output from a Time-Mark Generator to the Y INPUT connector of the oscilloscope through a Type 4285 50-ohm termination and a Type 2592-B Terminal Adapter.
3. Set generator to 500 μSEC and adjust the front-panel screwdriver X CAL control for precisely 1 timing marker/cm.
4. Set EXPANDER VERNIER switch to CAL X1.
5. Set generator for 5 mSEC.
6. Set 10:1 ADJ potentiometer R2013 for precisely 1 timing marker/cm.

5-17. SWEEP ADJUSTMENTS

a. Sweep Length Adjustment (R3536)

The Sweep LENGTH potentiometer is provided so that the trace may be adjusted to display a horizontal scan of 10 to 11.5 centimeters when oscilloscope is set up for calibrated unexpanded sweep.

1. Set up the oscilloscope to obtain a normal calibrator display on the screen.
2. Adjust Sweep LENGTH potentiometer R3536, until the display occupies 10.5 cm of horizontal deflection.

b. Fast Sweep Calibration Adjustment (C2052)

1. Apply a 5-microsecond time-marker signal from a Fairchild Type 781 Generator through a properly terminated cable to the Y INPUT connector.
2. Adjust the Y VOLTS/CM switch to give the display a vertical amplitude of about 4 centimeters.
3. Set TIME/CM switch to 5 μSEC and push in PULL VARIABLE control.
4. Using an insulated screwdriver, adjust trimmer C2052 for one pulse per centimeter.

Note: A tabulation check of all sweep ranges is shown in the *Sweep Check Calibration Chart* located in Section 4 of this manual.

5-18. 230-VOLT OPERATION

A small slide switch is provided at the rear of this instrument for switching from 115V to 230V operation and vice versa.

CAUTION

Make sure the 115V/230V change-over switch is set for the proper line voltage before connecting the unit to the mains.

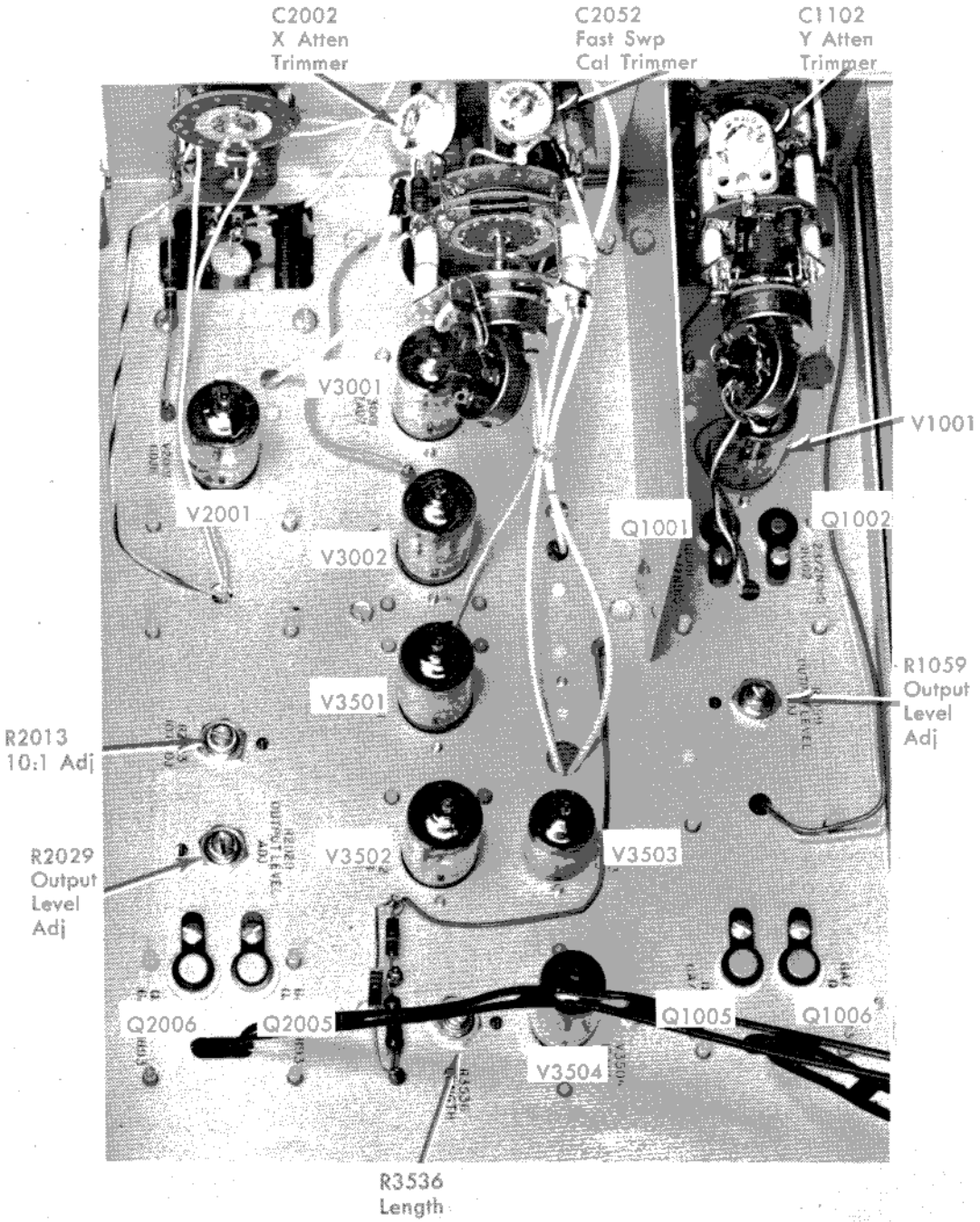


Figure 5-3. Top View Showing Tubes, Transistors and Adjustments

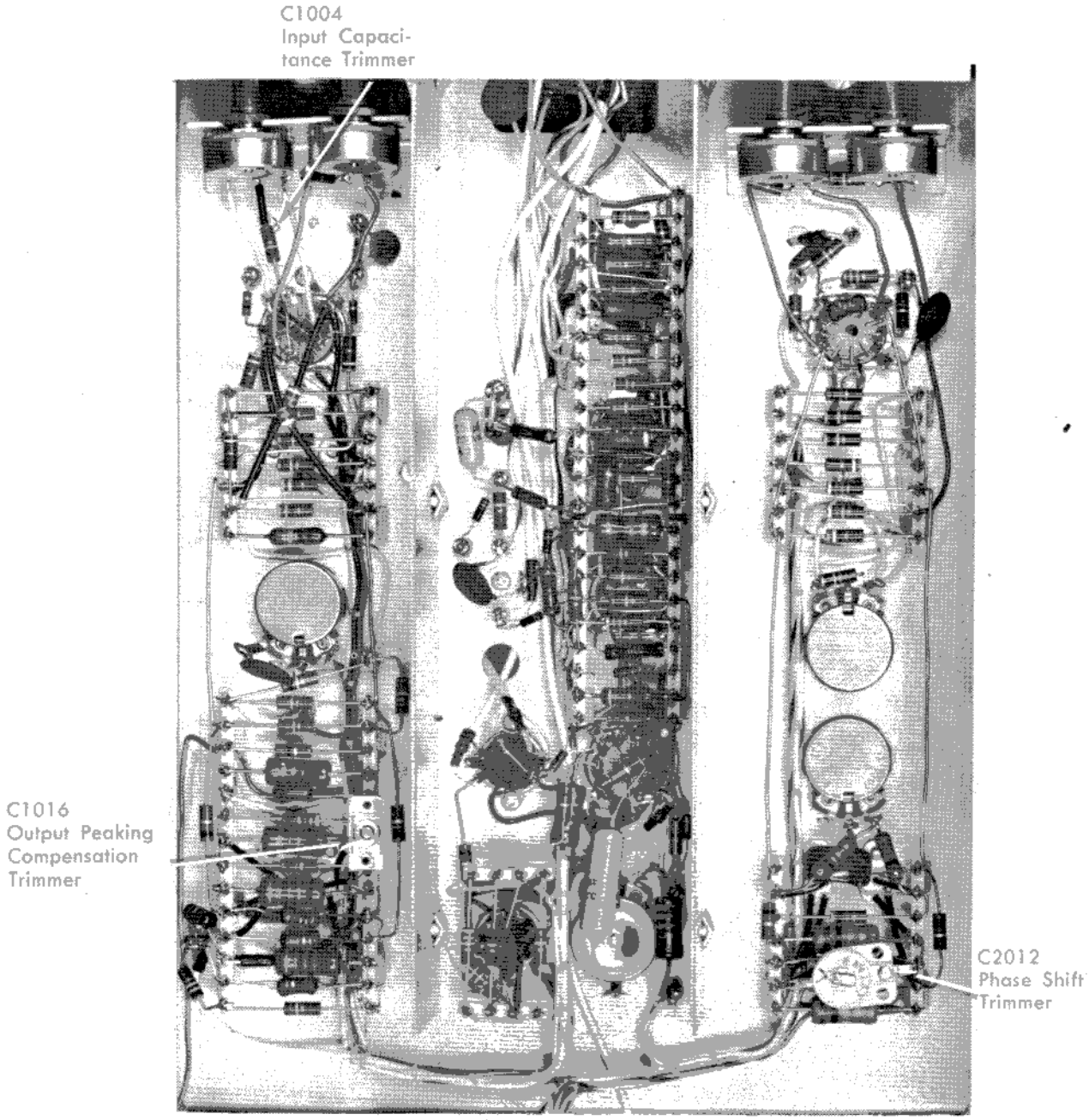


Figure 5-4. Bottom View Showing Adjustments

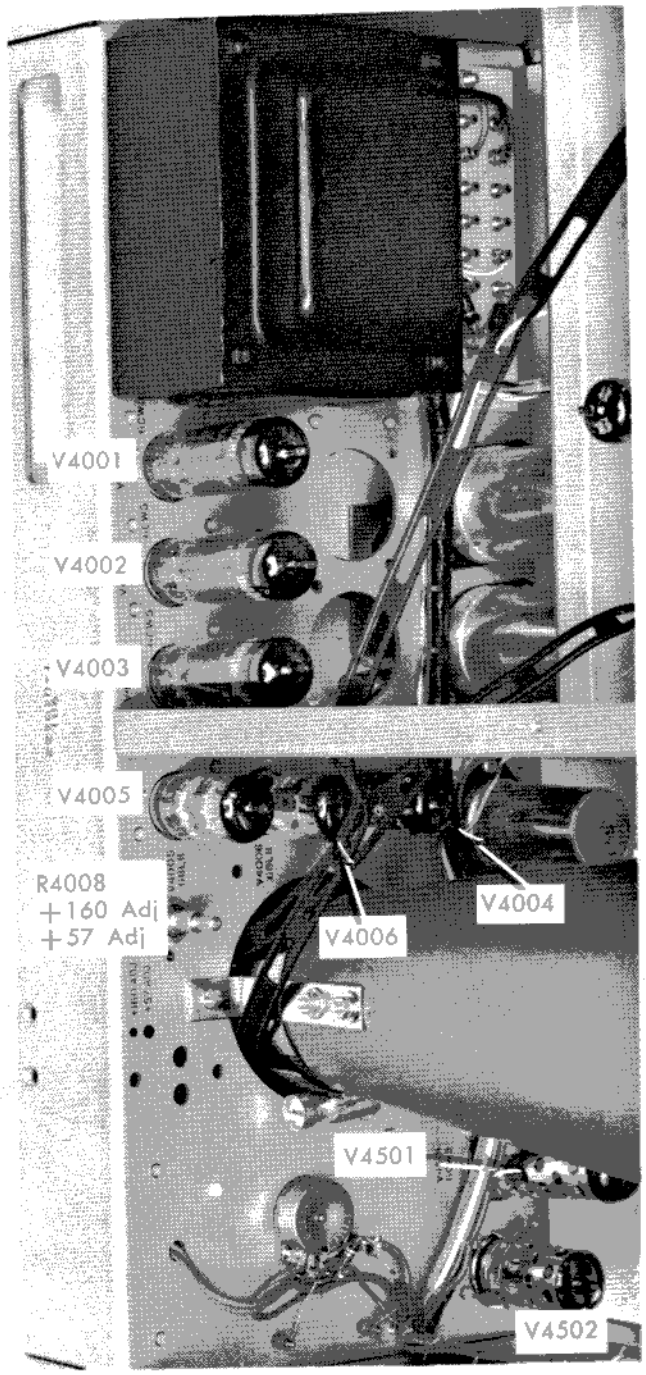


Figure 5-5. Rear Oblique View Showing Tubes and Adjustments

Symbol	Part Number	Description	Recommended Vendor Code	Type
		FUSES		
F410	1100 0990	2 amperes, slow blow (115V)	LFI	313002
		ELECTRICAL CONNECTORS		
J1001 & J1002	5101 2551	binding post (Y INPUT)	ABD	
J1003	5101 2553	binding post (Y INPUT GND)	ABD	
J2001	5101 2551	binding post (X INPUT)	ABD	
J3001	5101 2551	binding post (TRIG IN)	ABD	
J3002	5101 2553	binding post (TRIG GND)	ABD	
J4001	0903 7410	jack tip, black (CAL 0.5V p-p)	UCN	No. 118930
J4002	0904 4234	receptacle, ac, modified	ABD	
		TRANSISTORS		
Q1001 & Q1002	2600 7080	DU #2B	FCI	
	2600 7050	alternate 2N915		
Q1005 & Q1006	2600 7270	DU #6A	FCI	
	2600 7250	alternate 2N1893		
Q2005 & Q2006	2600 7270	DU #6A	FCI	
	2600 7250	alternate 2N1893		
Q4001	2600 7270	DU #6A	FCI	
	2600 7250	alternate 2N1893		
Q4007	2600 7210	DU #5	FCI	
	2600 7200	alternate 2N697		
		RESISTORS (1000)		
Note:	All resistors are fixed, film, ±5%, ½W, and values in ohms unless othewise specified; K = thousand, M = million			
R1001	0235 6210	composition, 100K, ±10%, ¼W	ALB	CB
R1002	0235 5970	composition, 1K, ±10%, ¼W	ALB	CB
R1003	0235 6210	composition, 100K, ±10%, ¼W	ALB	CB
R1004	0235 5970	composition, 1K, ±10%, ¼W	ALB	CB
R1005	0203 0760	composition, 15K	ALB	EB
R1006	0109 1350	variable, composition, 250, ±20% (DC BAL)	CTS	45
R1008	0203 0340	composition, 270	ALB	EB
R1009	0203 0620	composition, 3.9K	ALB	EB
R1010	0203 0720	composition, 10K, ±5%	ALB	EB
R1011	0203 0620	composition, 3.9K, ±10%, 4W (FINE/COARSE)	ALB	EB
R1012	0109 1360	variable, composition, 50K, ±20%, 1/3W (CAL ADJ)	CTS	45
R1013	0203 0560	composition, 2.2K	ALB	EB
R1014 & R1015	0203 0930	composition, 75K	ALB	EB
R1016 (part of S112)	0107 2772	variable, composition, 10K, ±20% (VERNIER GAIN)	ABD	
R1017 & R1018	0203 0280	composition, 150	ALB	EB
R1019 & R1020	0203 0600	composition, 3.3K	ALB	EB
R1021	0234 9340	16K, 1W	CGW	C-32
R1022	0203 0620	composition, 3.9K	ALB	EB
R1023	0203 0890	composition, 51K, ±10%	ALB	EB
R1024	0109 0040	variable, composition, 100K, ±20%, 1/3W (POSITION)	CTS	45
R1025	0203 0890	composition, 51K, ±10%	ALB	EB
R1026 & R1027	0203 1650	composition, 100, ±10%	ALB	EB
R1028	0203 0370	composition, 360	ALB	EB
R1029	0237 1130	18K, 2W	CGW	C42S
R1030	0203 0280	composition, 150	ALB	EB
R1031	0237 1130	18K, 2W	CGW	C42S
R1032	0203 0960	composition, 100K		
R1033	0203 1580	composition, 27, ±10%	ALB	EB
R1034 R1035 & R1036	0236 9790	7.5K, ±2%, 2W	CGW	C32S
R1037	0203 1050	composition, 240K	ALB	EB
R1038	0203 1130	composition, 510K	ALB	EB
R1039	0203 1220	composition, 1.2M	ALB	EB
R1059	0108 4680	variable, composition, 5K, ±20%, 1W (OUTPUT LEVEL ADJ)	CTS	#90CV
R1060	0203 1850	composition, 4.7K	ALB	EB
R1101	0236 5680	1K, ±1%	CGW	N20
R1102	0236 8950	10.1K, ±1%	CGW	N20
R1103	0204 1440	composition, 10M	IRC	GBT1/2
R1104	0236 8960	111K, ±1%	CGW	N20
R1110	0229 4990	1M, ±1%	ELC	DC1/2B
R1113	0229 4700	1M, ±1%	TEX	CD1/2PR
		RESISTORS (2000)		
R2003	0109 0040	variable, composition, 100K, ±20%, 1/3W (POSITION)	CTS	45
R2004	0203 0960	composition, 100K	ALB	EB
R2005 R2006	0203 0840	composition, 33K	ALB	EB
& R2007 R2008	0203 1690	composition, 220, ±10%	ALB	EB
& R2009	0203 0830	composition, 30K	ALB	EB
R2010	0203 1040	composition, 220K	ALB	EB
R2011	0203 0460	composition, 820	ALB	EB
R2012 (part of S204)	0107 2764	variable, composition, 30K ¼W (VERNIER)	ABD	
R2013	0108 4770	variable, composition, 200K, ±20%, 1W (10:1 ADJ	CTS	90CV
R2014	0203 0830	composition, 30K	ALB	EB
R2015	0203 0580	composition, 2.7K	ALB	EB
R2016 R2017	0109 1360	variable, composition, ±20%, ⅓W (CAL ADJ)	CTS	45
& R2018	0203 0620	composition, 3.9K	ALB	EB
R2019	0203 0960	composition, 100K	ALB	EB
R2021	0109 1370	variable, composition, 100K, ±20%, 1/3W (EXP BAL)	CTS	45
R2022 R2023	0203 0960	composition, 100K	ALB	EB
& R2024 R2025	0203 0950	composition, 91K	ALB	EB
& R2026 R2027	0203 1650	composition, 100, ±10%	ALB	EB
& R2028	0234 9360	20K, 1W	CGW	C32
R2029	0108 4680	variable, composition, 5K, ±20%, 1W OUTPUT LEVEL ADJ)	CTS	90CV
R2032 R2033	0203 0350	composition, 300	ALB	EB
& R2034	0239 1396	10K, 2W	CGW	C42
R2035	0236 6930	20K, ±1%	CGW	NS20
R2036	0229 4680	2M, ±1%	TEX	CD1/2PR
R2037	0229 5010	1.82M, ±1%	ELC	MF7C
R2038	0236 7980	200K, ±1%	CGW	NS20
R2051 (part of S202)	0107 2771	variable, composition, 50K, 13W (TIME/CM)	ABD	
R2052 R2053	0203 0790	composition, 20K	ALB	EB
& R2054	0234 2270	10M, ±1%	TEX	CD1/2SR
R2055	0234 2260	6M, ±1%	TEX	CD1/2SR
R2056	0229 4680	2M, ±1%	TEX	CD1/2PR
R2057	0229 4990	1M, ±1%	ELC	DC1/2B
R2058	0234 2270	10M, ±1%	TEX	CD1/2SR
R2059	0229 4990	1M, ±1%	ELC	DC1/2B
		RESISTORS (3000)		
R3001	0203 1890	composition, 10K, ±10%	ALB	EB
R3002	0203 0960	composition, 100K	ALB	EB
R3003	0203 1200	composition, 1M	ALB	EB
R3004	0203 1040	composition, 220K	ALB	EB
R3005	0203 1000	composition, 150K	ALB	EB

Symbol	Part Number	Description	Recommended Vendor Code	Type
R3006 (part of S313)	0107 2741	variable, composition, 500K, ¼ W (TRIG LEVEL)	ABD	
R3007	0203 0890	composition, 51K	ALB	EB
R3008	0203 1650	composition, 100, ±10%	ALB	EB
R3009	0203 0720	composition, 10K	ALB	EB
R3010	0203 0930	composition, 75K	ALB	EB
R3011	0203 1650	composition, 100, ±10%	ALB	EB
R3012	0234 9260	7.5K, 1W	CGW	C32
R3013	0234 9470	56K, 1W	CGW	C32
R3014	0203 0690	composition, 7.5K	ALB	EB
R3015 & R3016	0234 8540	24K	CGW	C32
R3017	0234 9480	68K, 1W	CGW	C32
R3018 & R3019	0203 0880	composition, 47K	ALB	EB
R3021	0203 1650	composition, 100, ±10%	ALB	EB
R3022	0203 1270	composition, 2M	ALB	EB
R3023	0203 0540	composition, 1.8K	ALB	EB
R3024	0236 7740	140K, ±1%	CGW	N20
R3025	0236 7770	150K, ±1%	CGW	N20
R3026	0203 1650	composition, 100, ±10%	ALB	EB
R3027	0203 0600	composition, 3.3K	ALB	EB
R3028	0203 0780	composition, 18K	ALB	EB
R3512	0203 0550	composition, 2K	ALB	EB
R3516	0203 1040	composition, 220K	ALB	EB
R3518	0236 7210	39.2K, ±1%	CGW	N20
R3519	0203 1650	composition, 100, ±10%	ALB	EB
R3521	0236 7040	26.1K, ±1%	CGW	N20
R3522	0236 3090	200K	CGW	C20
R3523	0203 1000	composition, 150K	ALB	EB
R3525 R3526 & R3527	0239 1408	30K, 2W	CGW	C42
R3528	0203 0890	composition, 51K	ALB	EB
R3529	0203 0900	composition, 56K	ALB	EB
R3530	0203 0960	composition, 100K	ALB	EB
R3531	0203 0520	composition, 1.5K	ALB	EB
R3532	0203 1080	composition, 330K	ALB	EB
R3533	0203 0870	composition, 43K	ALB	EB
R3534	0203 0930	composition, 75K	ALB	EB
R3535	0203 1650	composition, 100, ±10%	ALB	EB
R3536	0239 1383	3.3K, 2W	CGW	C42
R3537	0109 1310	variable, composition, 1.5K (LENGTH)	CTS	Series 45
R3538	0239 1389	5.6K, 2W	CGW	C42
R3539	0236 7440	68.1K, ±1%	CGW	N20
R3540	0234 9440	43K, 1W	CGW	C32
R3541	0234 9280	9.1K, 1W	CGW	C32
R3542	0203 1650	composition, 100, ±10%	ALB	EB
R3543	0203 0540	composition, 1.8K	ALB	EB
R3544	0234 9420	36K, 1W	CGW	C32
R3545	0203 0770	composition, 16K	ALB	EB
R3546	0203 0870	composition, 43K	ALB	EB
R3547	0203 1440	composition, 10M	ALB	EB
R3548	0203 2130	composition, 1M, ±10%	ALB	EB
	0203 1610	composition, 47, ±10%	ALB	EB

RESISTORS (4000)

R4000	0239 1491	100K, ±10%, 2W	CGW	C42
R4001	0203 1280	composition, 2.2M	ALB	EB
R4002	0203 0820	composition, 27K	ALB	EB
R4003	0234 5170	80, 3W	DAL	CS-2B
R4004 R4005	0203 1770	composition, 1K, ±10%	ALB	EB
& R4006	0203 0070	composition, 20	ALB	EB
R4007	0234 8540	24K	CGW	C20
R4008 F, R	0109 1560	variable, wire wound, 10K/10K, ±10% (+57/+160 ADJ)	CTS	C2-AW
R4009	0234 8620	51K	CGW	C20
R4010	0203 1770	composition, 1K, ±10%	ALB	EB
R4013	0203 1270	composition, 2M	ALB	EB
R4014	0203 1800	composition, 1.8K, ±10%	ALB	EB
R4015	0203 1340	composition, 3.9M	ALB	EB
R4016	0203 2040	composition, 180K, ±10%	ALB	EB
R4017	0203 1120	composition, 470K	ALB	EB
R4018	0203 0720	composition, 10K	ALB	EB

Symbol	Part Number	Description	Recommended Vendor Code	Type
R4019	0236 7740	140K, ±1%	CGW	C20
R4021	0236 7260	44.2K, ±1%	CGW	N20
R4026	0203 1770	composition, 1K, ±10%	ALB	EB
R4029	0203 1770	composition, 1K, ±10%	ALB	EB
R4031	0203 1770	composition, 1K, ±10%	ALB	EB
R4032 (part of S411)	0107 2344	variable, wire wound, 50, ±10%, 2W (SCALE)	ABD	
R4033	0203 1770	composition, 1K, ±10%	ALB	EB
R4034	0203 2130	composition, 1M, ±10%	ALB	EB
R4035	0234 8630	56K	CGW	C20
R4036	0234 8610	47K	CGW	C20
R4037	0234 9290	10K, 1W	CGW	C32
R4038	0203 1770	composition, 1K, ±10%	ALB	EB
R4040	0210 6100	wire wound, 1.5K, 10W	SPG	10KT
R4041	0203 1270	composition, 2M, ±10%	ALB	EB
R4043	0203 1770	composition, 1K, ±10%	ALB	EB
R4051	0239 1406	24K, 2W	CGW	C42
R4052	0203 0930	composition, 75K	ALB	EB
R4053	0236 7740	140K, ±1%	CGW	N20
R4054	0236 6910	19.1K, ±1%	CGW	N20
R4055	0235 5350	453, ±1%	CGW	N20
R4056	0236 4430	49.9, ±1%	CGW	N20
R4057	0239 1406	24K, 2W	CGW	C42
R4058	0203 0640	composition, 4.7K	ALB	EB
R4300	0236 9060	wire wound, 3.3K, 20W	TRU	MOR-20
R4500 R4501	0203 4300	composition, 2.7M, 1W	ALB	GB
& R4502	0203 7270	composition, 2M, 2W	ALB	GB
R4503	0108 0760	variable, composition, 2.5M (FOCUS)	CLS	37
R4504	0203 1150	composition, 620K	ALB	EB
R4505	0109 1340	variable, composition, 100K, ¼ W (HV ADJ)	CTS	45
R4506	0203 7270	composition, 2M, 2W	ALB	GB
R4507	0203 1150	composition, 620K	ALB	EB
R4508	0203 1610	composition, 47, ±10%	ALB	EB
R4509	0109 0080	variable, composition, 500K, ±20%, 1W (INTENSITY)	CLS	Series 53C
R4511	0203 1020	composition, 180K	ALB	EB
R4512	0203 1120	composition, 470K	ALB	EB
R4513	0234 8580	36K	CGW	C20
R4515	0234 8690	100K	CGW	C20
R4516	0203 2150	composition, 1.5M, ±10%	ALB	EB
R4517	0203 1610	composition, 47, ±10%	ALB	EB
R4518	0203 1030	composition, 200K	ALB	EB
R4519	0203 1610	composition, 47, ±10%	ALB	EB
R4520	0203 1690	composition, 220, ±10%	ALB	EB
R4521	0228 3980	7.5K, 3W	CGW	LP13
R4522	0203 2130	composition, 1M, ±10%	ALB	EB
R4523	0109 1340	variable, composition, 100K, ¼ W (ASTIG)	CTS	45
R4524	0203 0870	composition, 43K	ALB	EB
R4525	0203 0820	composition, 27K	ALB	EB
R4526	0234 8610	47K	CGW	C20
R4527	0234 8570	33K	CGW	C20
R4528	0236 7290	47.5K, ±1%	CGW	N20
R4529 R4531	0236 7140	33.2K, ±1%	CGW	N20
& R4532	0203 1670	composition, 150, ±10%	ALB	EB
R4533	0234 8520	20K	CGW	C20

SWITCHES

S102	0503 2410	push-push, SPST, 0.5 ampere, 115 volts ac (BEAM FINDER)	GRY	#4002
S110	0501 7061	rotary, 6 positions, 3 sections, (Y VOLTS/CM)	ABD	
S111	0503 1330	slide, DPDT (AC/DC)	STC	SS50
S112 (part of R1016)	0107 2772	SPDT, 3 amperes, 10K, ±20%, 125V (PULL VARIABLE)	ABD	
S201	0503 1330	slide, DPDT (AC/DC)	STC	SS50

Symbol	Part Number	Description	Recommended Vendor Code	Type
S202 (part of R2051)	0107 2771	VARIABLE (PULL)	ABD	
S203	0501 7531	rotary, 18 positions, 3 sections, SPDT, 3 amperes, 125V (TIME/CM)	ABD	
S204 (part of R2012)	0107 2764	25K, ±30%, 25W (EXP VERNIER)	ABD	
S310	0503 2140	slide, DP3T, 0.5 ampere, 125 volts, ac, dc, 3 positions (TRIG SOURCE)	MUT	No. 5608
S311	0503 2140	slide, DP3T, 0.5 ampere, 125 volts, ac, dc, 3 positions (TRIG COUPLING)	MUT	No. 5608
S312	0503 1330	slide, DPDT (TRIG SLOPE)	STC	SS50
S313 (part of R3006)	0107 2741	phenolic, 2 positions, 1 section, ¼W (AUTO)	ABD	
S352	0503 1330	slide, DPDT (SINGLE/NORMAL)	STC	SS50
S410	0503 2420	thermostatic (THERMAL CUT-OUT)	EMW	2200
S411 (part of R4032)	0107 2344	DPST, 3 amperes, 125V (POWER)	ABD	
S415	0503 2480	slide, DPDT, 115V/230V	MUT	4633

TRANSFORMERS

T4001	2001 3791	power	ABD	
T4501	2001 3801	high voltage power supply	ABD	

ELECTRON TUBES

Symbol	Part Number	Description	Recommended Vendor Code	Type
V1001	2501 1610	ECC82/12AU7	AMX	
V2001	2501 2220	6DJ8/ECC88	AMX	
V3001	2501 1610	ECC82/12AU7	AMX	
V3002	2501 2220	6DJ8/ECC88	AMX	
V3501 & V3502	2501 2220	6DJ8/ECC88	AMX	
V3504	2500 9110	12AU6	EIA	
V4001 to V4003	2501 2400	6CW5/EL86	AMX	
V4004	2500 0810	5651	EIA	
V4005 & V4006	2501 3460	6BL8/ECF80	AMX	
V4501	2501 2400	6CW5/EL86	AMX	
V4502	2501 3460	6BL8/ECF80	AMX	
V4504	*2501 0541	F7010-0-P1	ABD	
	*2501 0542	F7010-0-P2G		
	*2501 0543	F7010-0-P2B		
	*2501 0544	F7010-0-P7		
	*2501 0545	F7010-0-P11		
	*2501 0546	F7010-0-P31		

* Depending on sales order

CABLE

W4001	5030-1390	assembly	MIL	18/SJT
	0905 9000	adapter connector, 125V, 15 amperes		

SECTION 6B
SPARE PARTS LIST

SPARE PARTS REQUIREMENTS

a. General

The Type 701 Oscilloscope is an extremely reliable and dependable instrument. Only components thoroughly tested and approved by the engineers of the Quality Assurance Laboratory are used in this instrument. Continued performance tests, environmental and life testing of production units make certain your oscilloscope will give many years of satisfactory service. These new Fairchild oscilloscopes are precision engineered and require no selected parts.

Two lists of "running spares" are included to aid you in periodic maintenance. The running-spare parts lists include recommended quantities and reference symbol numbers. Section 6A of this Instruction Manual gives a complete listing of all components and their recommended vendors so that you may readily procure them from a local supply house or your own stores.

Note: The local Fairchild Scientific Instrument Field Engineering representative and his service organization can assist you in obtaining any additional components in the shortest possible time. To help expedite service, always give Type Number and Serial Number of the instrument; always specify the part number and give a description of the component (see Section 6A of this manual).

b. 500-Hour Spares (6 months)

The recommended list for one through three units follows.

Fuses

Symbol	Quantity
F410	2

Electron Tubes

V1001	1
V2001	2
V3504	1
V4001	2
V4004	1
V4005	1

Transistors

Q1001	2
Q1005	2
Q4007	2

Diodes

CR3501	2
CR3507	1
CR3508	1
CR4001	2
CR4501	1

Lamps

DS4001	1
DS4002	2

c. 2000-Hour Spares (2 years)

The recommended list for one through five units is given below. Maintain spares indicated plus one for each oscilloscope in use; 2 of each set of the 500-hour spare list given in paragraph (b) plus the quantities listed as follows:

Capacitors

Symbol	Quantity	Symbol	Quantity
C1001	1	C3001	1
C1002	1	C3002	1
C1004	1	C3003	1
C1005	1	C3004	1
C1008	1	C3005	1
C1011	1	C3008	1
C1012	1	C3009	1
C1013	3	C3507	1
C1014	2	C3509	1
C1015	1	C3512	1
C1101	1	C4001	1
C1102	1	C4002	4
C1103	1	C4003	1
C1104	1	C4004	1
C2002	1	C4005	1
C2004	1	C4006	1
C2007	1	C4012	1
C2008	1	C4502	1
C2010	1	C4505	1
C2011	1	C4506	1
C2012	1	C4509	1
C2051	1	C4510	1
C2053	1	C4511	1
C2054	1	C4514	1
C2055	1	C4518	1
C2056	1		

Lamps

Symbol	Quantity
DS4001	1
DS4002	2

Electrical Connectors

J1001	2
J1003	1
J4001	1
J4002	1

Resistors

Symbol	Quantity	Symbol	Quantity
R1001	1	R1008	1
R1002	1	R1009	2
R1005	1	R1012	2
R1006	1	R1013	1

Symbol	Quantity
R1014	2
R1017	1
R1019	1
R1021	1
R1023	2
R1024	1
R1026	6
R1028	1
R1029	1
R1033	1
R1035	1
R1037	1
R1038	1
R1039	1
R1059	1
R1060	1
R1032	3
R1034	3
R1101	1
R1102	1
R1103	1
R1104	1
R1110	2
R2001	1
R2002	1
R2005	1
R2006	1
R2008	1
R2010	1
R2011	1
R2012	1
R2021	1
R2023	1
R2027	1
R2032	1
R2033	1
R2035	1
R2036	1
R2037	1
R2038	1
R2052	1
R2053	1
R2055	1
R2056	1
R2015	1
R3001	1
R3002	1
R3003	1
R3004	1
R3005	1
R3006	1
R3009	1
R3012	1
R3013	1
R3014	1
R3015	1
R3017	1
R3018	1
R3022	1
R3023	1
R3024	1
R3025	1
R3512	1
R3518	1

Symbol	Quantity
R3521	1
R3522	1
R3525	1
R3528	1
R3530	1
R3531	1
R3532	1
R3535	1
R3536	1
R3537	1
R3538	1
R3539	1
R3540	1
R3543	1
R3544	1
R3545	1
R3546	1
R3547	1
R4000	1
R4001	1
R4002	1
R4003	1
R4004	4
R4005	1
R4007	1
R4008	1
R4009	1
R4013	1
R4014	1
R4015	1
R4016	1
R4017	1
R4018	1
R4019	1
R4021	1
R4032	1
R4034	1
R4035	1
R4036	1
R4037	1
R4055	1
R4056	1
R4058	1
R4300	1
R4502	1
R4503	1
R4504	1
R4505	1
R4506	1
R4507	1
R4508	2
R4511	1
R4513	1
R4515	1
R4516	1
R4518	1
R4520	1
R4521	1
R4524	1
R4527	1
R4528	1
R4529	1
R4531	1
R4533	1

Transformers and Coil

Symbol	Quantity	
T4001	1	
T4501	1	
L4501	1	(For internal graticule CRT only)

Switches

Stock only one each of the following switches for each 3 units being maintained:

S102, S111, S201, S203, S310, S415

Note: Should a particular switch receive more than normal use in certain applications (such as the BEAM FINDER) then the quantity stocked of that particular switch should be doubled.

d. Miscellaneous

The following items may be stocked in quantities of one for each 2 units being maintained:

Name	Part Number
Bumper, rubber, black	3802 3120
Fuseholder	1100 1890
Light, jewel, red	1201 2010
Knob, black	4501 0400
Knob, black	4501 0380
Knob, red	4501 0410
Knob, binding post	4500 7131
Power cord	5030 1390
Adapter connector	0905 9000
Panel, Front	3201 4041

e. Summary

The quantities of spare parts given in the preceding paragraphs are intended for industrial and military duty under normal environment and heavy-use conditions. It is suggested that the maintenance engineer evaluate:

1. The conditions under which the instruments will be used.
2. The skill of the maintenance technicians.
3. Other similar items on hand.
4. The effect of procurement time of spares and effects of instrument down-time on your organization.

It is recommended that inventories of spare parts outlined above be adjusted according to the requirements of your own laboratory or plant.

In the first analysis, the factory recommends the availability of spares or standby equipments since extensive life testing of your instrument has shown no higher failure rate for any specific component.

ADDENDUM

TO

TYPE 700, 701 & 702 INSTRUCTION MANUALS

A. INTRODUCTION

This addendum pertains to the instruction manuals for the equipments listed below. It should be inserted in manuals for equipments bearing a Code Number the same or higher than that shown here.

Type	Instruction Manual Part Number	Equipment Code Number
700	6704 7221	47
701	6704 2833	81
702	6704 4482	51

B. PURPOSE OF ENGINEERING CHANGE

To increase reliability of C4514 and C4515 by specifying capacitor types having a higher voltage rating.

C. PARTS LIST REVISIONS

In the Parts List, change the part number and description of C4514 and C4515 as indicated below.

	Symbol	Part No.	Description	Recommended Vendor Code	Type
FROM	C4514 & C4515	0317 2920	electrolytic, 12 uf, +100 -0%, 350V	CDE	BR1235
TO	C4514 & C4515	0326 2280	electrolytic, 15 uf, +50 -10%, 450V	SPG	DEE

D. SCHEMATIC REVISIONS

Change the value of C4514 and C4515 on the Schematic Diagram from 12 to 15 uf.

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6704 8741
PCN #32,609
(Code # - see paragraph A)

24 Mar 67

ADDENDUM

FOR

TYPE 701 OSCILLOSCOPE
(Reference Manual Part Number 6704 2833)

PHOTOGRAPHS

Figures 1-1, 2-3, 2-5, 4-1 and 6-1:

A 0.1V/CM position has been added to the XV/CM section of the TIME/CM switch. This addition is not shown in photographs contained in this manual and has been included in production units bearing serial numbers 6000 and up.

TEXT

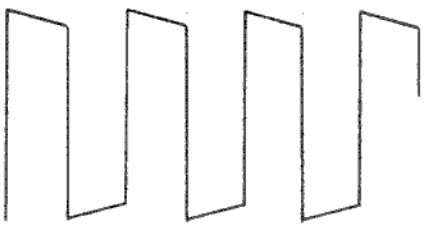
Section 5, Maintenance and Recalibration:

Page 5-4, paragraph 5-13, step 2, should read as follows:

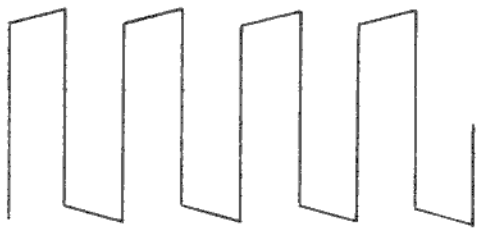
...Set the TIME/CM switch to X/CM 0.1V and Y VOLTS/CM switch to 0.1V...

Page 5-5, Figure 5-2b and 5-2c:

Revised pictures should be as follows:



b



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ADDENDUM

TO

TYPE 701/702 INSTRUCTION MANUALS
Fairchild Part Nos. 6704 2833 and 6704 4482

A. PURPOSE OF ENGINEERING CHANGE

To eliminate parallax errors in measuring the displayed waveform. This is accomplished by incorporating into the equipment a CRT with an internal graticule. A beam rotate coil has also been added to simplify trace alignment procedures.

B. PARTS LIST REVISIONS

Revise the instruction manual parts list as shown below.

	Symbol	Part Number	Description	Recommended Vendor Code	Type
***CHANGE:	R4523	0107 2732	variable, composition, 100K/20K/20K, +20% (BEAM ROTATE)	CTS	C45-2-45
	**V4504	(part numbers and descriptions unchanged)			
ADD:	R4530	0203 0640	composition, 4.7K	ALB	EB
	L4501	2101 8441	coil, beam rotate	FI	
	V4504	2501 1011*	F7010-6-P1	FI	
		2501 1012*	F7010-6-P2G		
		2501 1013*	F7010-6-P2B		
		2501 1014*	F7010-6-P7		
		2501 1015*	F7010-6-P11		
		2501 1016*	F7010-6-P31		

Also, add the following note after listing of Electron Tubes:

**Customer option in lieu of CRT's 2501 1011 through 2501 1016.

***Symbol remains unchanged.

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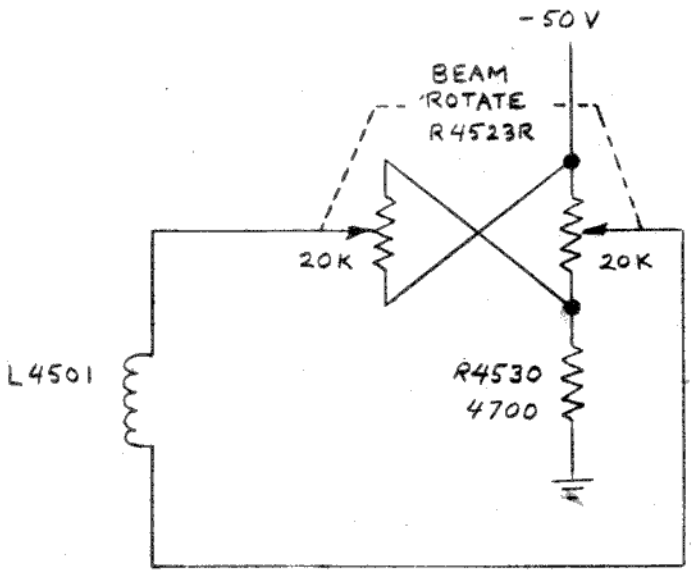
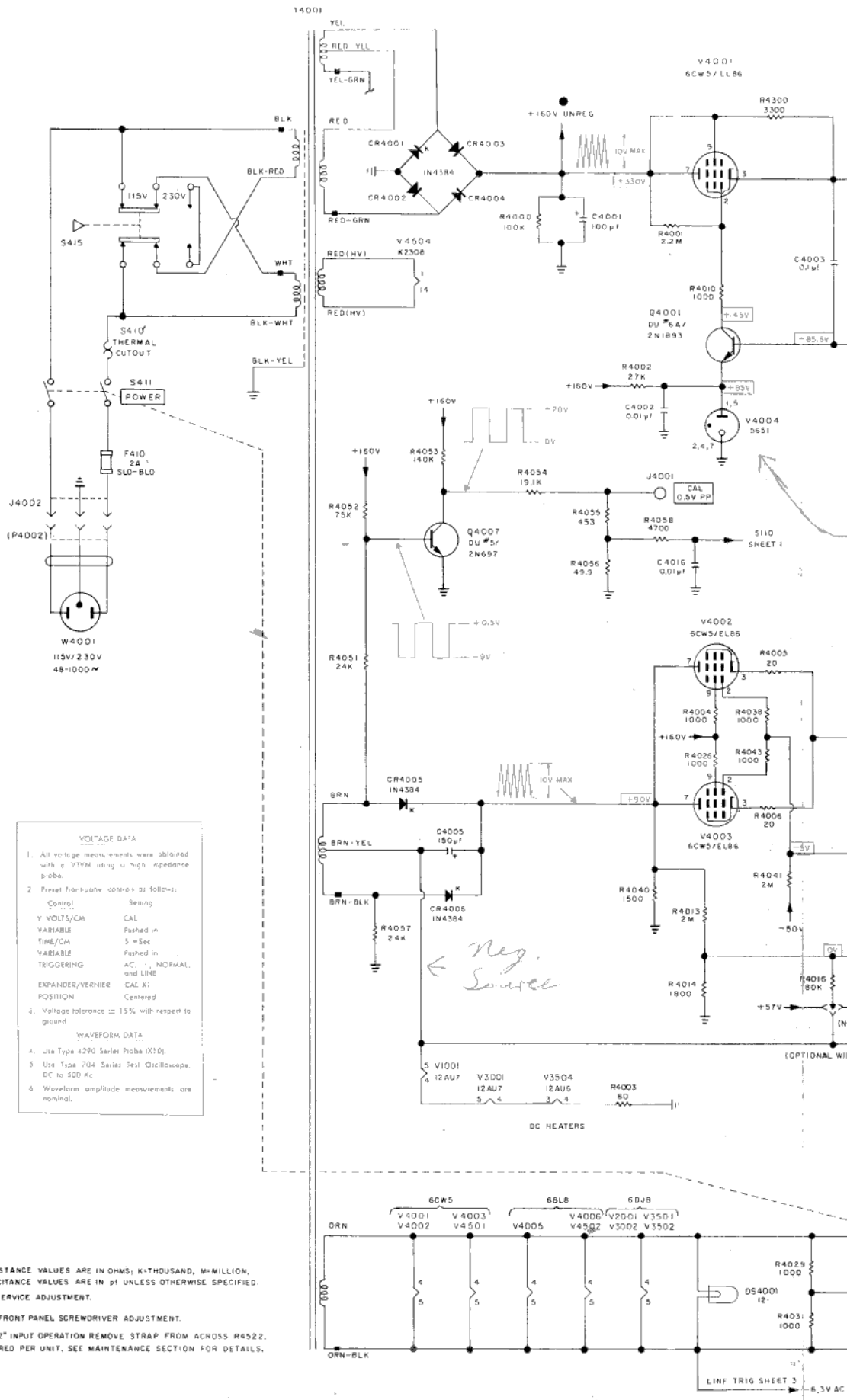
C. SCHEMATIC DIAGRAM REVISIONS

1. Change V4504 to Type F7010-6-P.

2. Add the following circuit:



+160V REGULATOR



VOLTAGE DATA

1. All voltage measurements were obtained with a VTVM using a high impedance probe.
2. Preset front-panel controls as follows:

Control	Setting
Y VOLTS/CM	CAL
VARIABLE	Pushed in
TIME/CM	5 mSec
VARIABLE	Pushed in
TRIGGERING	AC, ⌒, NORMAL, and LINE
EXPANDER/VERNIER	CAL X1
POSITION	Centered

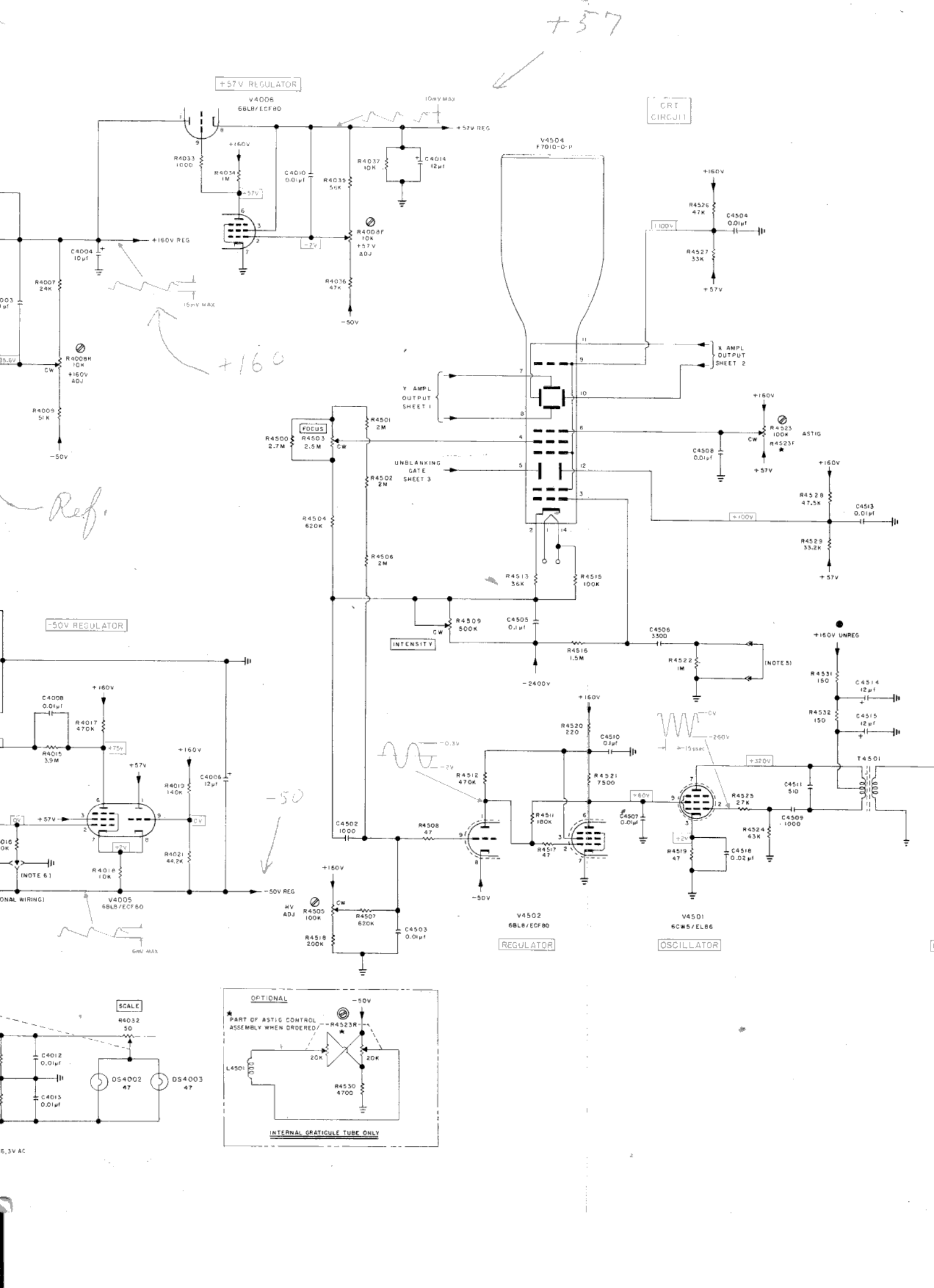
3. Voltage tolerance ± 15% with respect to ground

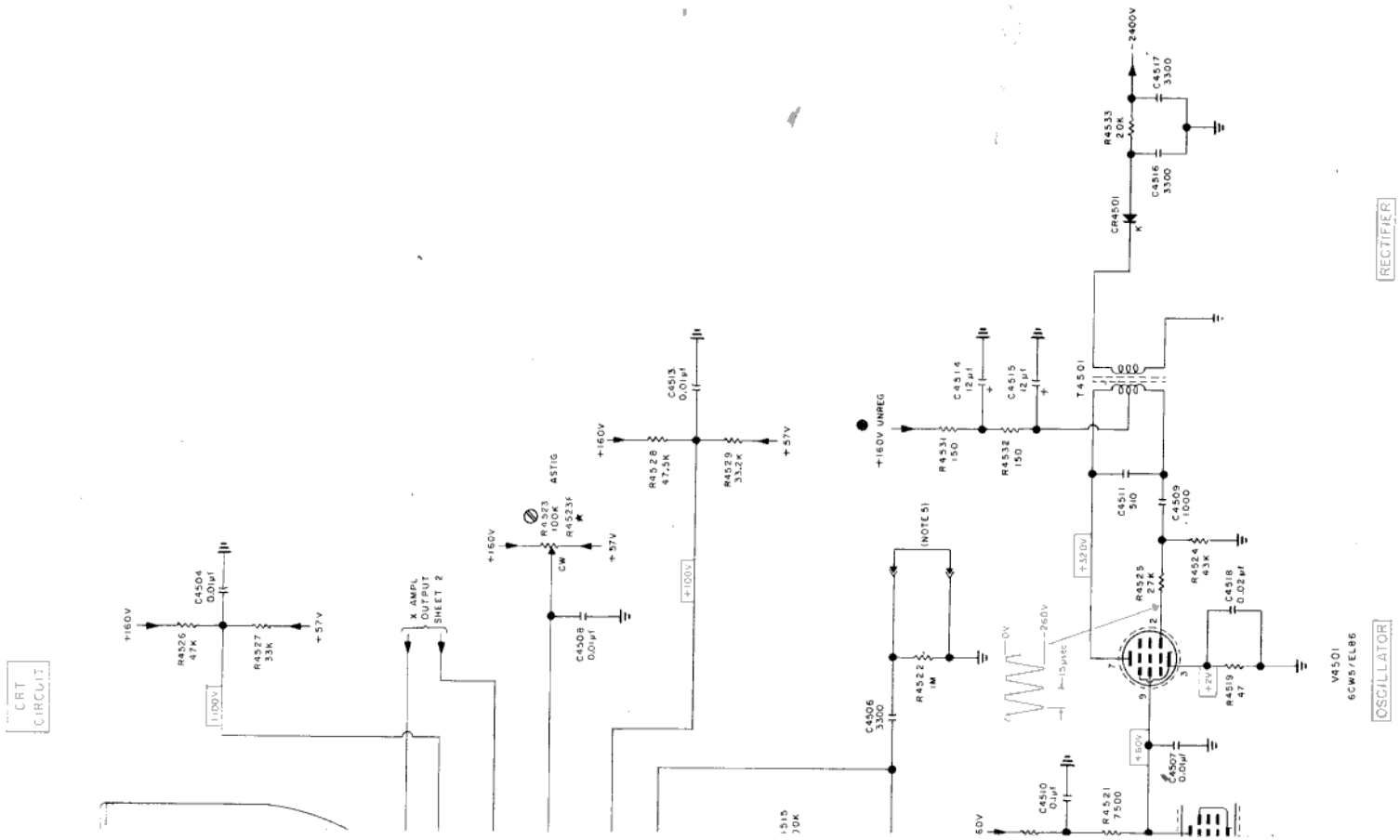
WAVEFORM DATA

4. Use Type 4290 Series Probe (X10).
5. Use Type 704 Series Test Oscilloscope, DC to 500 Kc.
6. Waveform amplitude measurements are nominal.

NOTES:

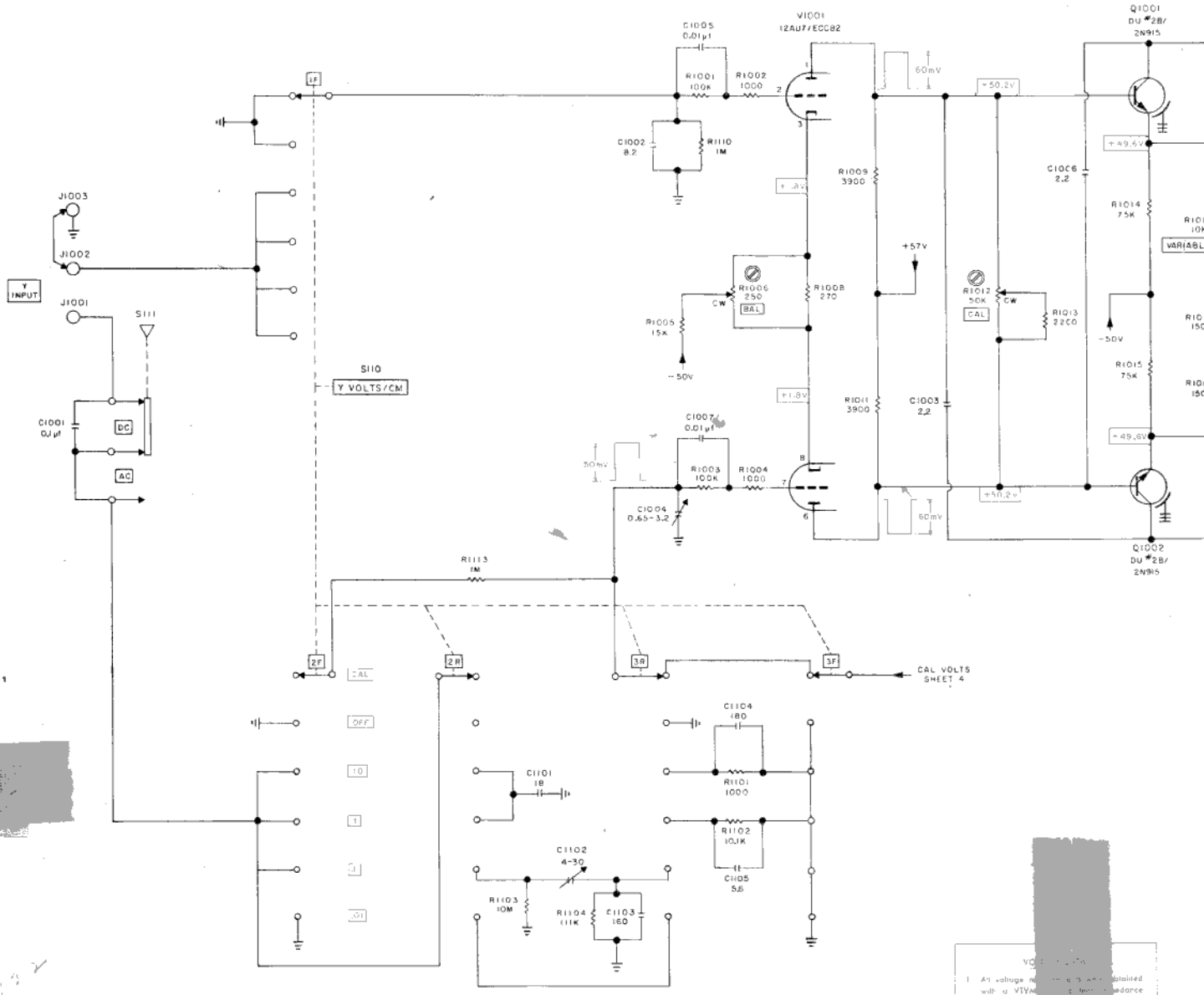
1. RESISTANCE VALUES ARE IN OHMS; K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN pf UNLESS OTHERWISE SPECIFIED.
3. ⊘ SERVICE ADJUSTMENT.
4. ⊘ FRONT PANEL SCREWDRIVER ADJUSTMENT.
5. FOR "2" INPUT OPERATION REMOVE STRAP FROM ACROSS R4522.
6. TAILORED PER UNIT. SEE MAINTENANCE SECTION FOR DETAILS.


+57V REGULATOR
V4006
6BL8/ECF80
10mV MAX
+57V REG
+160V
R4033 1000
R4034 1M
+57V
C4010 0.01µf
R4035 56K
R4037 10K
C4014 12µf
R4008F 10K +57V ADJ
-2V
+160V REG
C4004 10µf
15mV MAX
R4007 24K
R4036 47K
-50V
R4008R 10K +160V ADJ
CW
R4009 51K
-50V REGULATOR
C4008 0.01µf
R4017 470K
R4015 3.9M
+160V
+57V
C4006 12µf
R4013 140K
R4021 44.2K
R4018 10K
(NOTE 6)
V4005
6BL8/ECF80
-50V REG
6mV MAX
V4504
F7010-0-P
CRT CIRCUIT
+160V
R4526 47K
C4504 0.01µf
1100V
R4527 33K
+57V
X AMPL OUTPUT SHEET 2
Y AMPL OUTPUT SHEET 1
FOCUS
R4501 2M
R4500 2.7M
R4503 2.5M
CW
R4502 2M
R4504 620K
R4506 2M
UNBLANKING GATE SHEET 3
R4523 100K ASTIG
R4523F
C4508 0.01µf
+160V
+57V
R4528 47.5K
C4513 0.01µf
+100V
R4529 33.2K
+57V
R4513 36K
R4515 100K
R4509 500K
C4505 0.1µf
INTENSITY
R4516 1.5M
-2400V
C4506 3300
R4522 1M
(NOTE 5)
+160V UNREG
R4531 150
C4514 12µf
R4532 150
C4515 12µf
T4501
+320V
C4511 510
C4509 1000
R4525 27K
R4524 43K
C4518 0.02µf
R4519 47
+2V
-260V
15µsec
-0.3V
-2V
R4520 220
C4510 0.1µf
R4521 7500
+80V
C4507 0.01µf
R4512 470K
R4511 180K
R4517 47
C4502 1000
R4508 47
-50V
+160V
HV ADJ
R4505 100K
CW
R4507 620K
C4503 0.01µf
R4518 200K
V4502
6BL8/ECF80
REGULATOR
V4501
6CW5/EL86
OSCILLATOR
SCALE
R4032 50
C4012 0.01µf
C4013 0.01µf
DS4002 47
DS4003 47
6.3V AC
OPTIONAL
-50V
★ PART OF ASTIG CONTROL ASSEMBLY WHEN ORDERED
R4523R
20K
20K
L4501
R4530 4700
INTERNAL GRATICULE TUBE ONLY


CRT CIRCUIT
RECTIFIER
OSCILLATOR
X AMPL OUTPUT SHEET 2
+160V
+57V
+100V
-2400V
+160V UNREG
+320V
-260V
(NOTE 5)
R4526 47K
R4527 33K
C4504 0.01µf
C4508 0.01µf
R4523 100K
R4523* *
CW
ASTIG
C4513 0.01µf
R4528 47.5K
R4529 33.2K
R4533 20K
C4517 3300
C4516 3300
CR4501
T4501
C4514 12µf
C4515 12µf
R4531 150
R4532 150
C4511 510
C4509 .1000
R4524 43K
R4525 2.7K
C4518 0.02µf
R4519 47
+12V
+60V
C4507 0.01µf
C4510 0.1µf
R4521 7500
C4506 3300
R4522 1M
V4501
6GW5/EL86

Vertical Deflection

~~HORIZONTAL~~ DEFLECTION

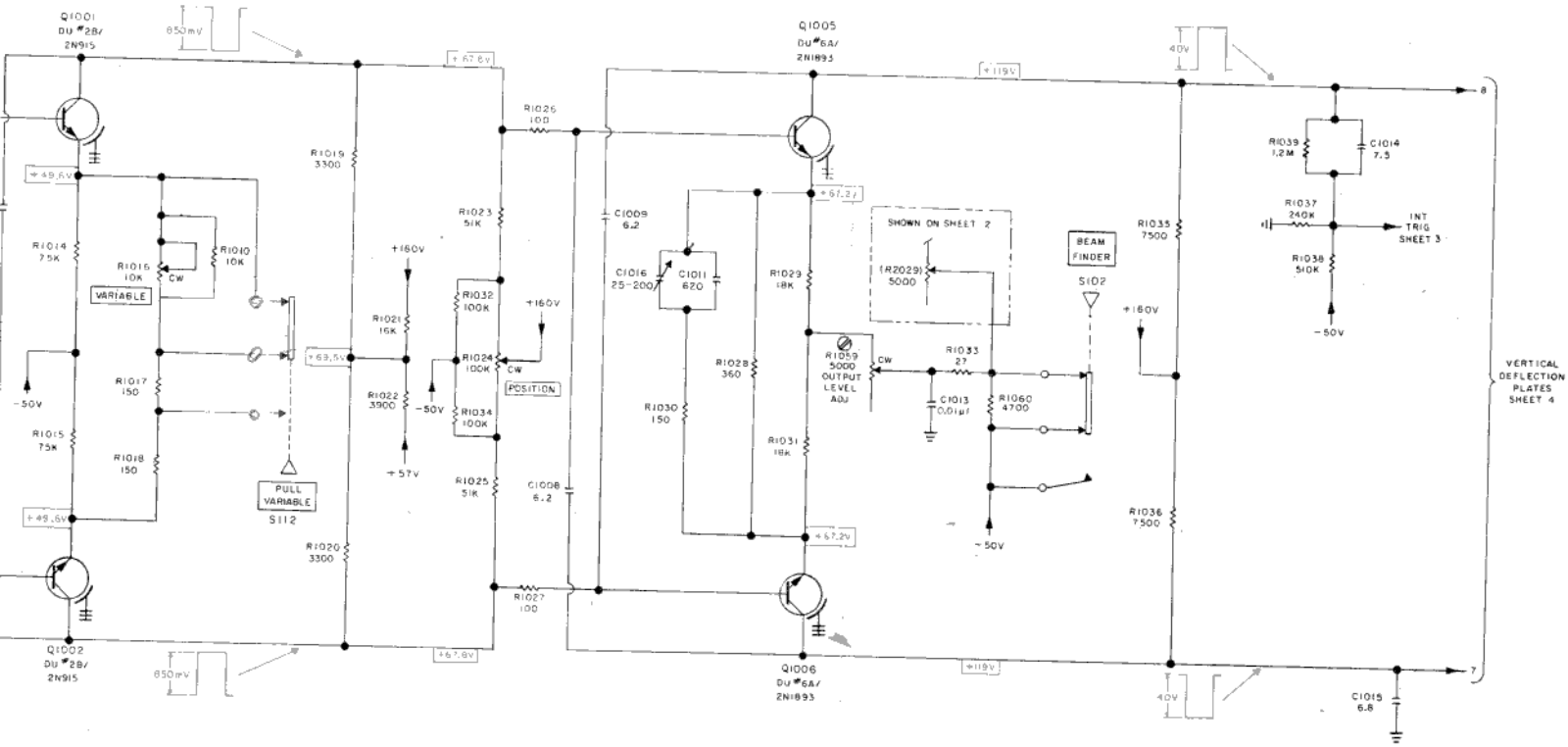


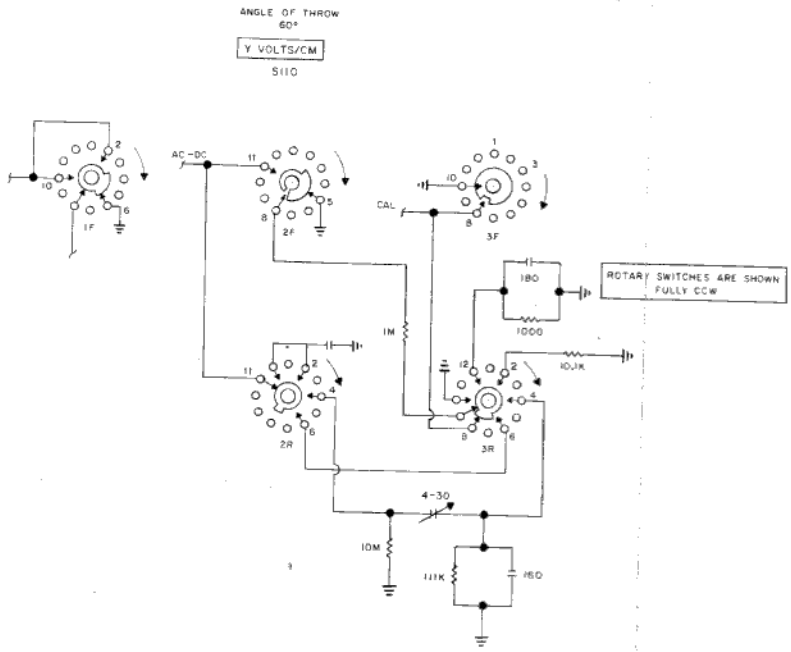
NOTES:

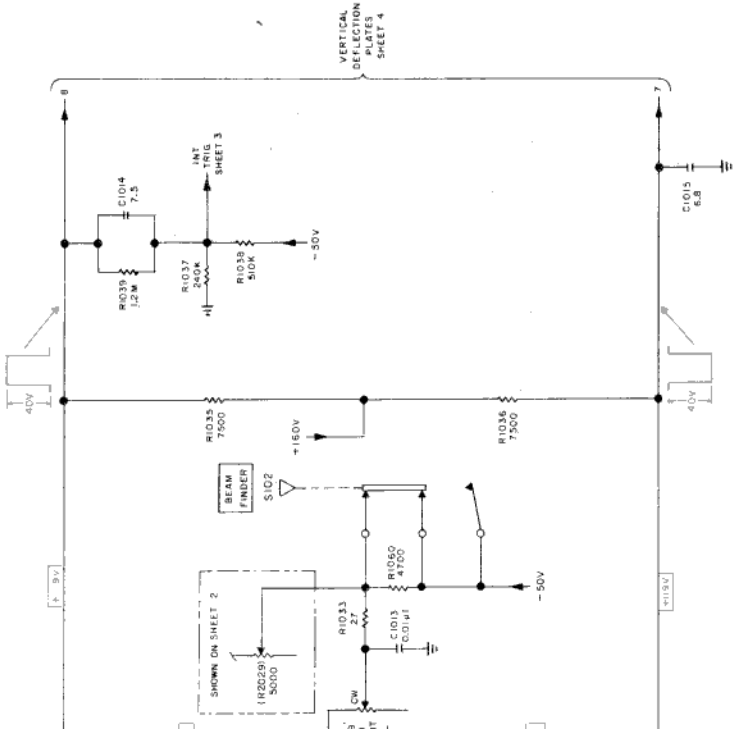
1. RESISTANCE VALUES ARE IN OHMS; K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN pf UNLESS OTHERWISE SPECIFIED.
3. ⊘ FRONT PANEL SCREWDRIVER ADJUSTMENT.
4. ⊘ SERVICE ADJUSTMENT.
5. HEAT SINK.

tical Deflection Amplifier

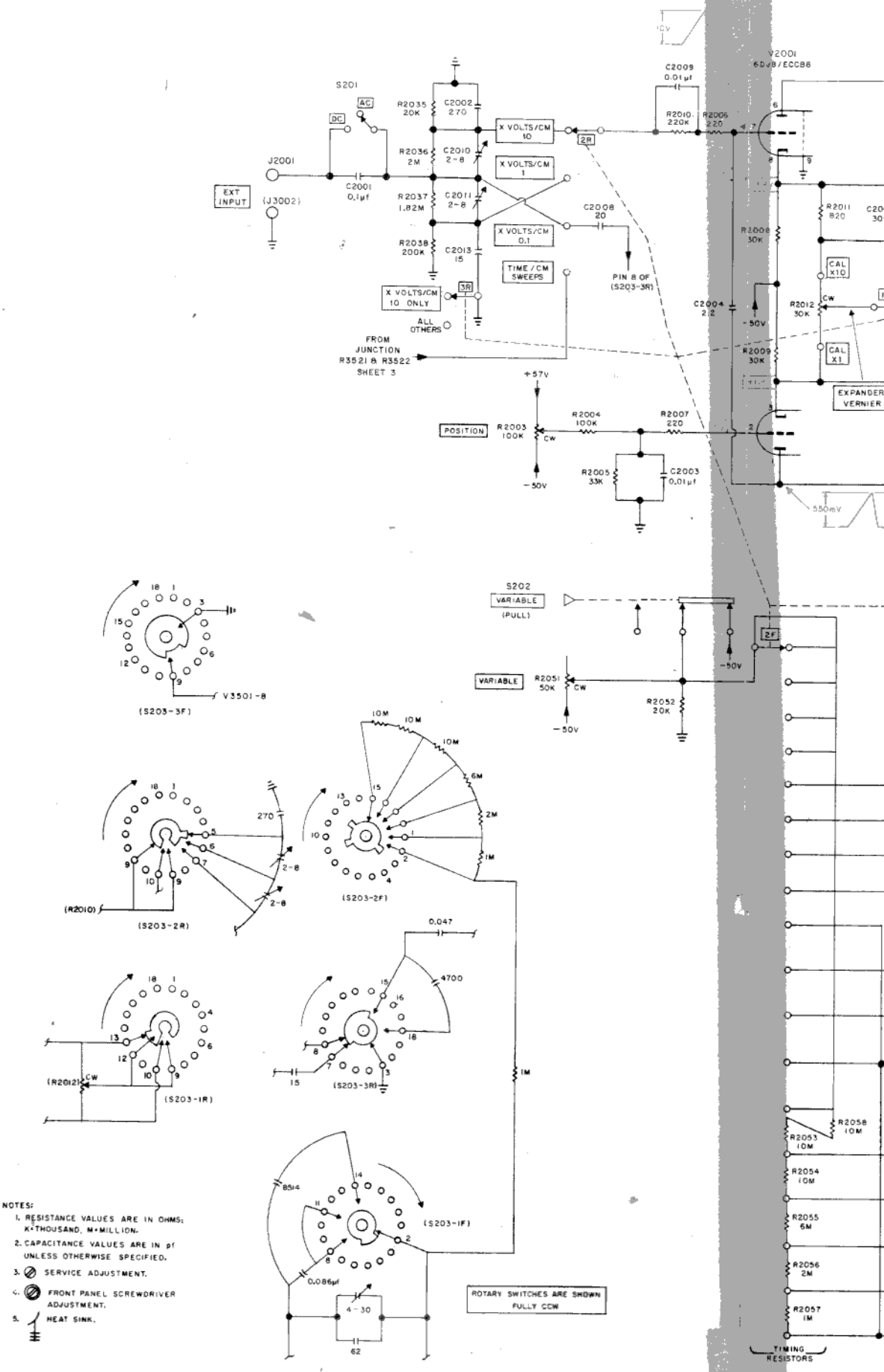
RIZONTAL DEFLECTION AMPLIFIER





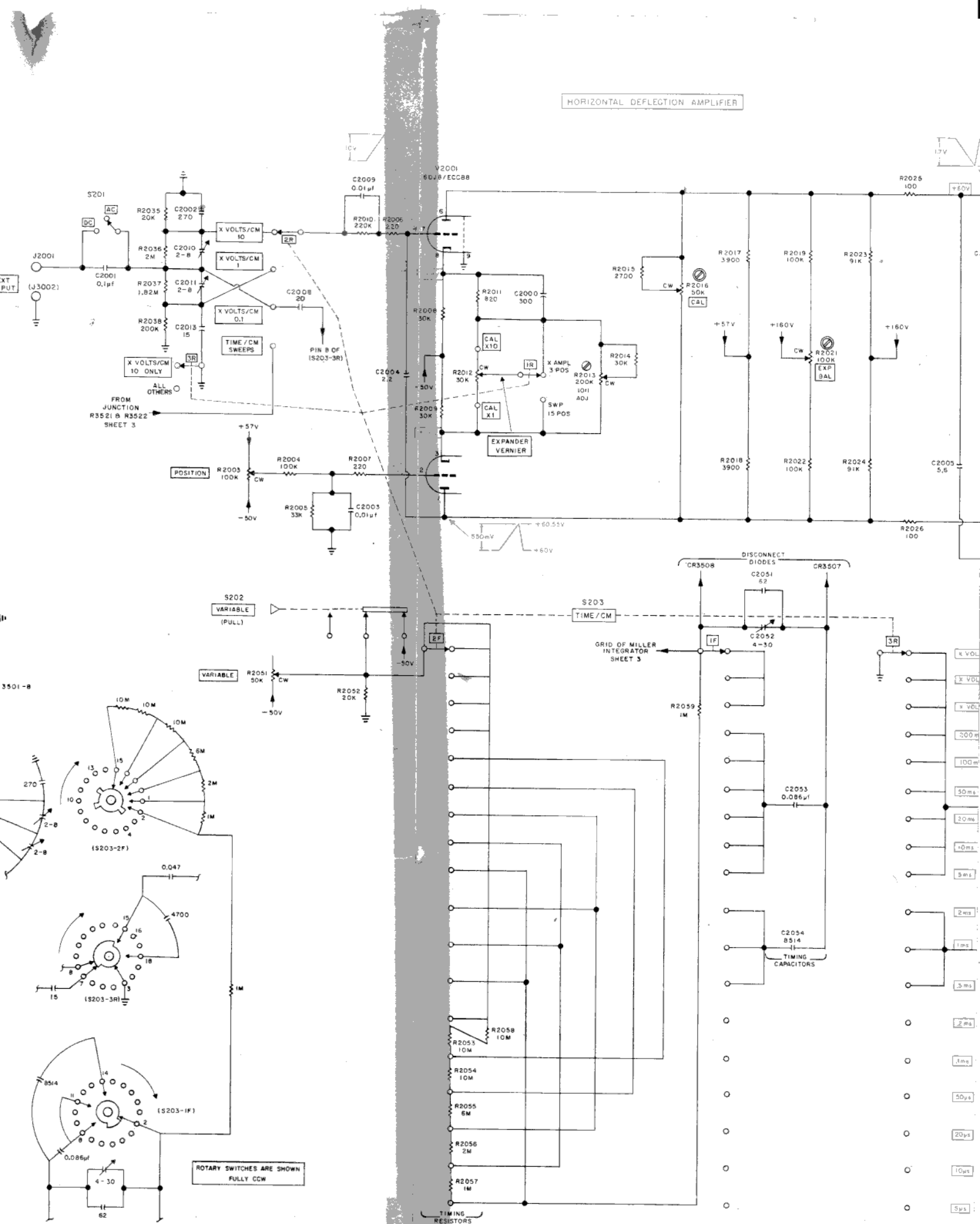


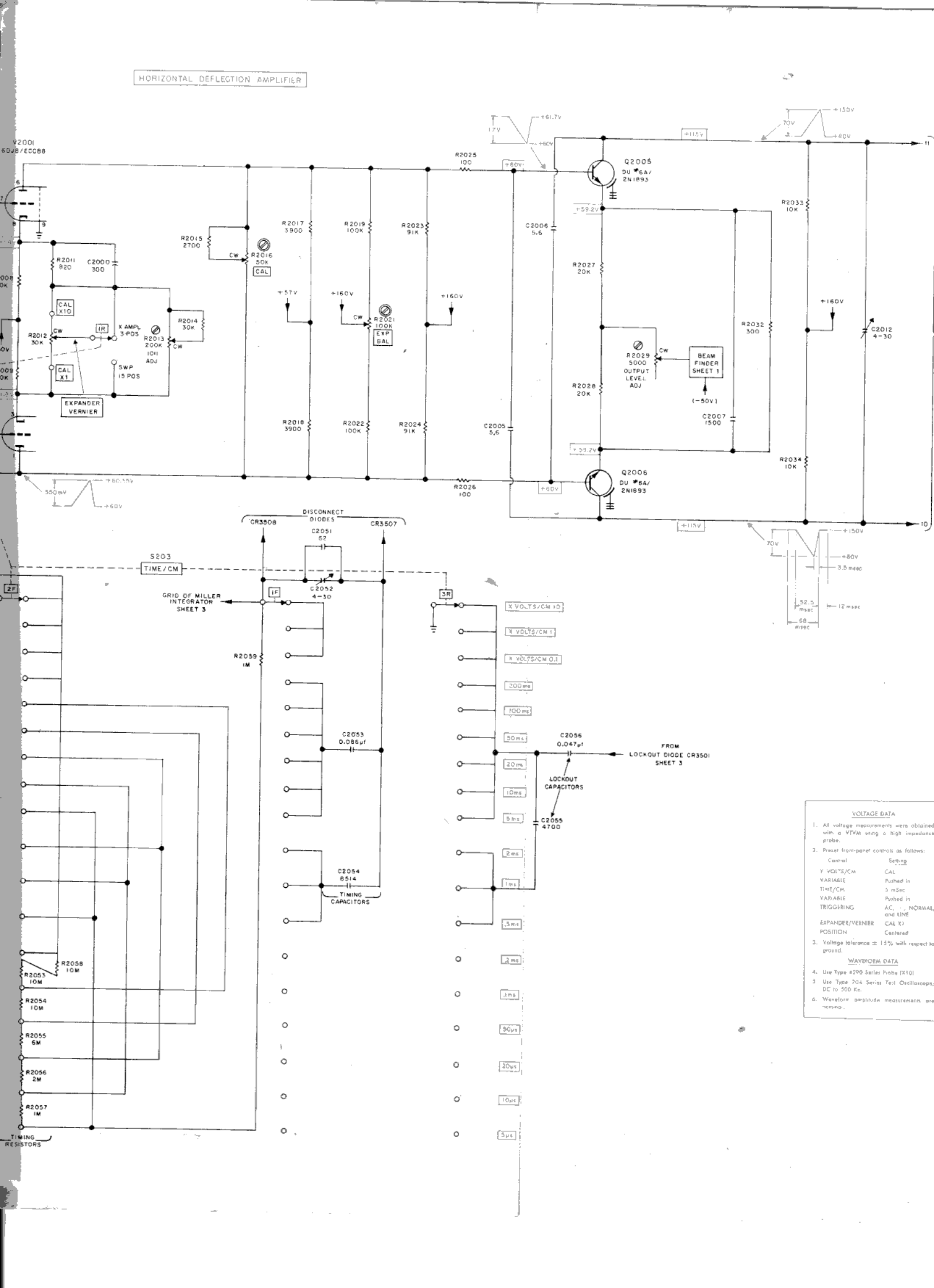
SWITCHES ARE SHOWN FULLY CCW

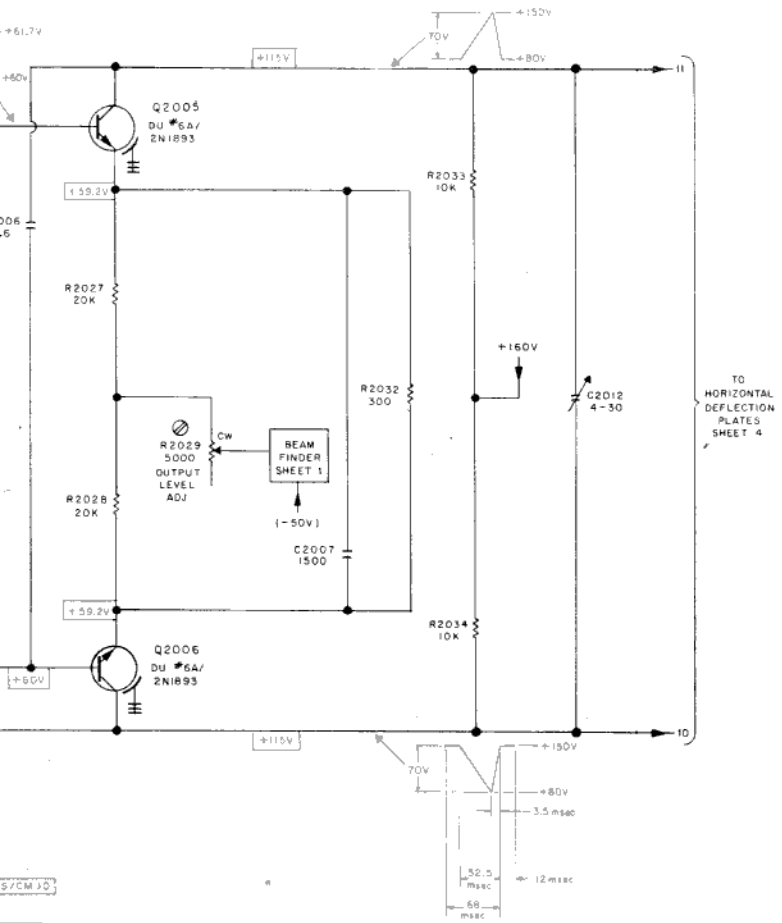


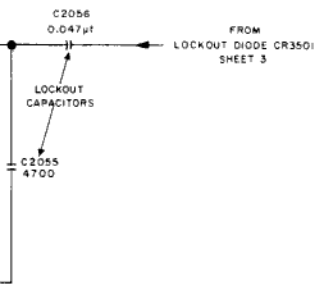
NOTES:

1. RESISTANCE VALUES ARE IN OHMS; K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN pf UNLESS OTHERWISE SPECIFIED.
3. ⊘ SERVICE ADJUSTMENT.
4. ⊘ FRONT PANEL SCREWDRIVER ADJUSTMENT.
5. HEAT SINK.


HORIZONTAL DEFLECTION AMPLIFIER
V2001 6DJ8/ECC88
S201
AC
DC
J2001
(J3002)
C2001 0.1μf
R2035 20K
C2002 270
R2036 2M
C2010 2-8
R2037 1.82M
C2011 2-8
R2038 200K
C2013 15
X VOLTS/CM 10
X VOLTS/CM 1
X VOLTS/CM 0.1
TIME/CM SWEEPS
X VOLTS/CM 10 ONLY
ALL OTHERS
2R
3R
C2009 0.01μf
R2010 220K
R2006 220
C2008 20
PIN 8 OF (S203-3R)
FROM JUNCTION R3521 & R3522 SHEET 3
C2004 2.2
R2008 30K
R2009 30K
R2011 820
C2000 300
CAL X10
CAL X1
R2012 30K
1R
X AMPL 3 POS
R2013 200K 10% ADJ
R2014 30K
SWP 15 POS
EXPANDER VERNIER
R2015 2700
R2016 50K CAL
R2017 3900
R2019 100K
R2023 91K
R2025 100
+60V
+57V
+160V
R2021 100K EXP BAL
R2018 3900
R2022 100K
R2024 91K
C2005 5.6
R2026 100
POSITION
R2003 100K
R2004 100K
R2007 220
R2005 33K
C2003 0.01μf
-50V
550mV
+60.55V
S202
VARIABLE
(PULL)
2F
VARIABLE
R2051 50K
R2052 20K
S203
TIME/CM
DISCONNECT DIODES
CR3508
CR3507
C2051 62
C2052 4-30
1F
GRID OF MILLER INTEGRATOR SHEET 3
R2059 1M
C2053 0.086μf
C2054 8514
TIMING CAPACITORS
R2058 10M
R2053 10M
R2054 10M
R2055 6M
R2056 2M
R2057 1M
TIMING RESISTORS
10M
6M
2M
1M
270
2-8
(S203-2F)
0.047
4700
(S203-3R)
8514
0.086μf
4-30
62
(S203-1F)
ROTARY SWITCHES ARE SHOWN FULLY CCW
X VOLTS
200mv
100mv
50ms
20ms
10ms
5ms
2ms
1ms
.5ms
.2ms
.1ms
50μs
20μs
10μs
5μs


HORIZONTAL DEFLECTION AMPLIFIER
V2001
6DJ8/ECC88
R2025
100
+80V
Q2005
DU *6A/
2N1893
+59.2V
C2006
5.6
R2033
10K
R2027
20K
R2032
300
C2012
4-30
+160V
R2028
20K
R2029
5000
OUTPUT
LEVEL
ADJ
CW
BEAM
FINDER
SHEET 1
(-50V)
C2007
1500
R2034
10K
Q2006
DU *6A/
2N1893
R2026
100
+115V
+150V
70V
+61.7V
1.7V
+60V
R2015
2700
R2016
50K
CAL
R2017
3900
R2019
100K
R2023
91K
+57V
+160V
R2021
100K
EXP
BAL
R2018
3900
R2022
100K
R2024
91K
C2005
5.6
R2011
820
C2000
300
CAL
X10
CAL
X1
IR
X AMPL
3 POS
SWP
15 POS
R2012
50K
R2013
200K
10X
ADJ
R2014
30K
EXPANDER
VERNIER
550mV
+60.55V
+60V
DISCONNECT
DIODES
CR3508
CR3507
C2051
62
S203
TIME/CM
C2052
4-30
2F
1F
3R
GRID OF MILLER
INTEGRATOR
SHEET 3
R2059
1M
X VOLTS/CM 10
X VOLTS/CM 1
X VOLTS/CM 0.1
200ms
100ms
50ms
20ms
10ms
5ms
2ms
1ms
.5ms
.2ms
.1ms
50µs
20µs
10µs
5µs
C2053
0.086µf
C2054
8514
TIMING
CAPACITORS
C2056
0.047µf
FROM
LOCKOUT DIODE CR3501
SHEET 3
LOCKOUT
CAPACITORS
C2055
4700
R2058
10M
R2053
10M
R2054
10M
R2055
5M
R2056
2M
R2057
1M
TIMING
RESISTORS
+150V
70V
+80V
3.5 msec
52.5
msec
12 msec
68
msec
VOLTAGE DATA
1. All voltage measurements were obtained with a VTVM using a high impedance probe.
2. Preset front-panel controls as follows:
Control Setting
Y VOLTS/CM CAL
VARIABLE Pushed in
TIME/CM. 5 mSec
VARIABLE Pushed in
TRIGGERING AC, NORMAL, and LINE
EXPANDER/VERNIER CAL X1
POSITION Centered
3. Voltage tolerance ± 15% with respect to ground.
WAVEFORM DATA
4. Use Type 4290 Series Probe (X10)
5. Use Type 204 Series Test Oscilloscope; DC to 500 Kc.
6. Waveform amplitude measurements are nominal.





VOLTAGE DATA

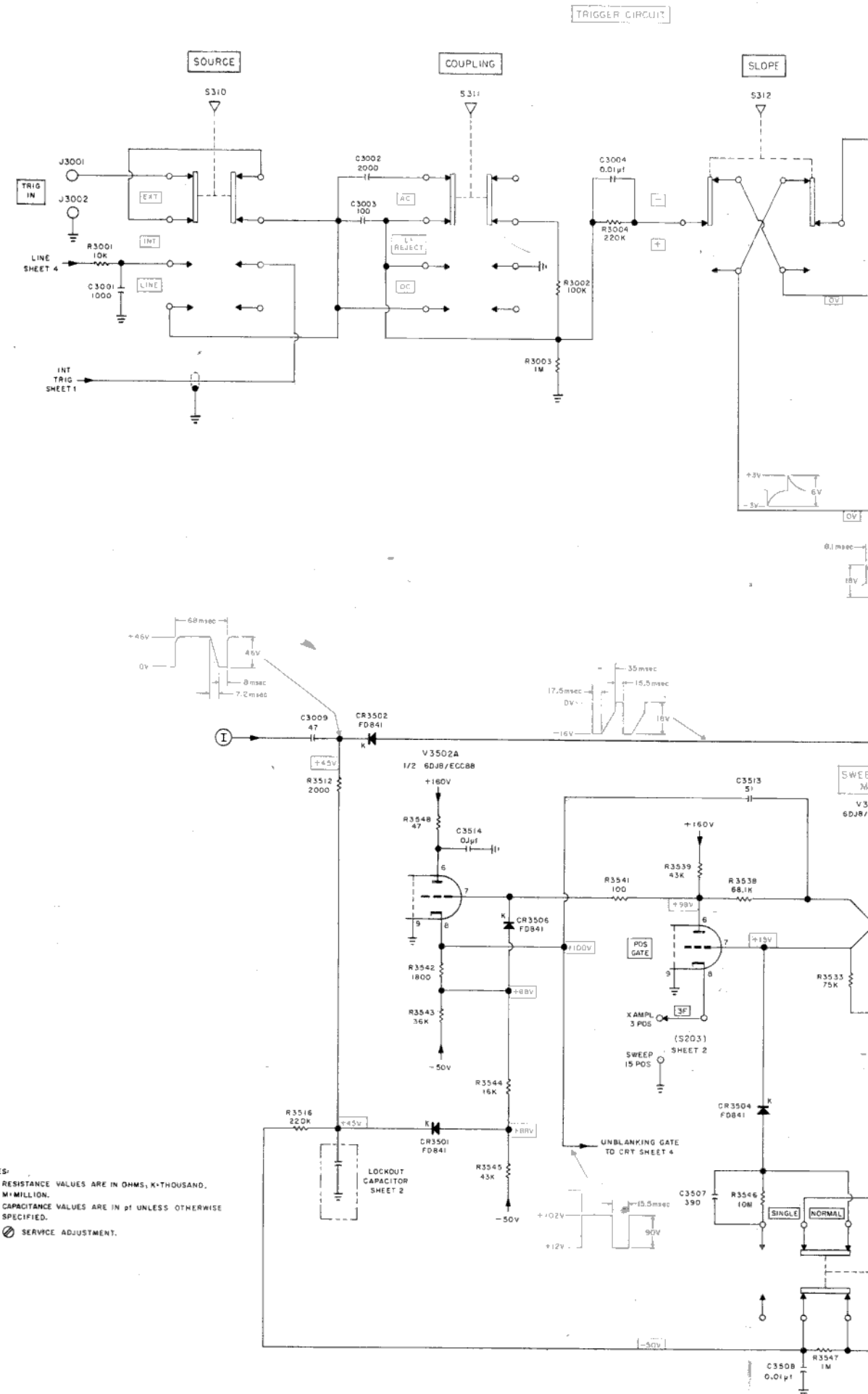
1. All voltage measurements were obtained with a VTVM, using a high impedance probe.
2. Preset front panel controls as follows:

Control	Setting
Y VOLTS/CM	CAL
VARIABLE	Pushed in
TIME/CM	5 mSec
VARIABLE	Pushed in
TRIGGERING	AC, ⊥, NORMAL, and LINE
EXPANDER/VERNIER	CAL X1
POSITION	Centered

3. Voltage tolerance ± 15% with respect to ground.

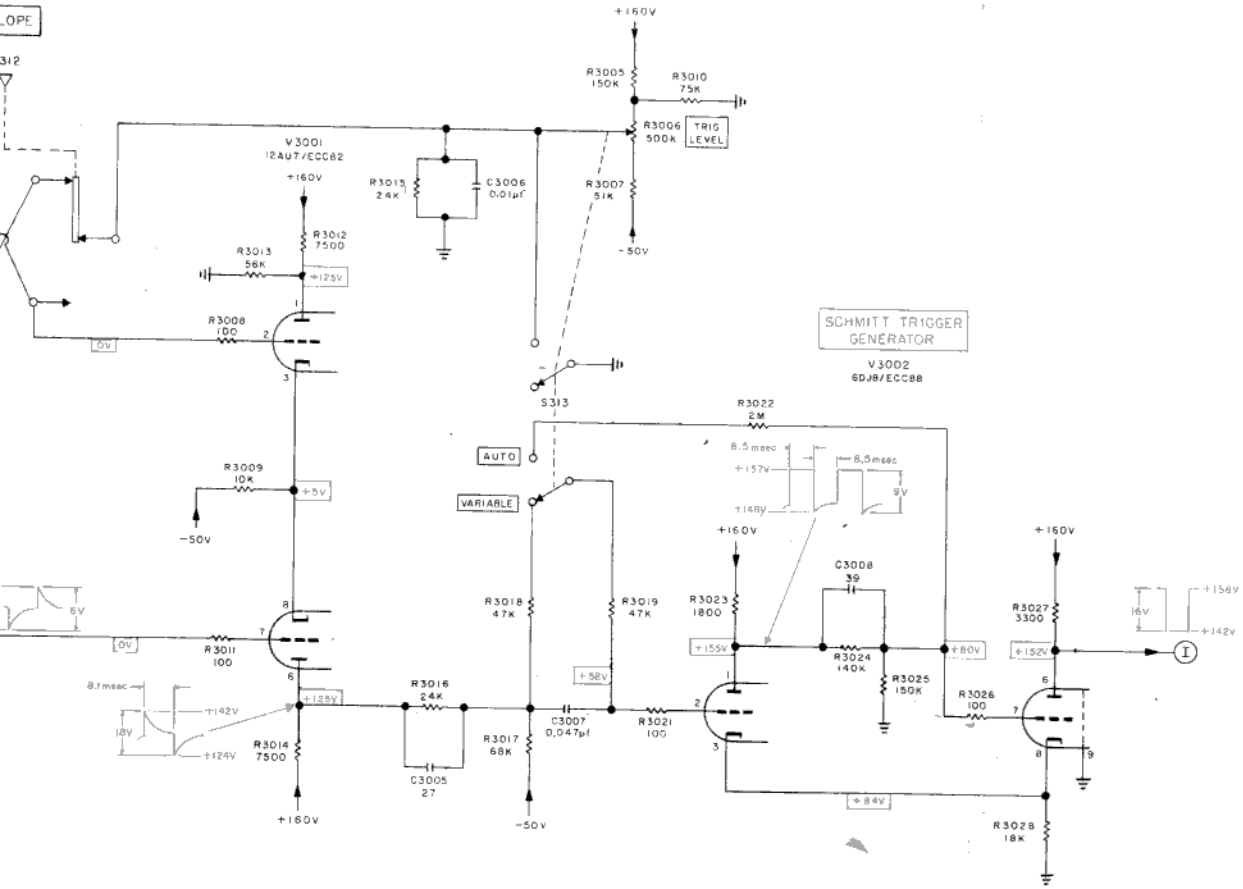
WAVEFORM DATA

4. Use Type 4290 Series Probe (X10).
5. Use Type 704 Series Test Oscilloscope; DC to 500 Kc.
6. Waveform amplitude measurements are nominal.



NOTES:

1. RESISTANCE VALUES ARE IN OHMS, K=THOUSAND, M=MILLION.
2. CAPACITANCE VALUES ARE IN pf UNLESS OTHERWISE SPECIFIED.
3. ⊘ SERVICE ADJUSTMENT.



VOLTAGE DA

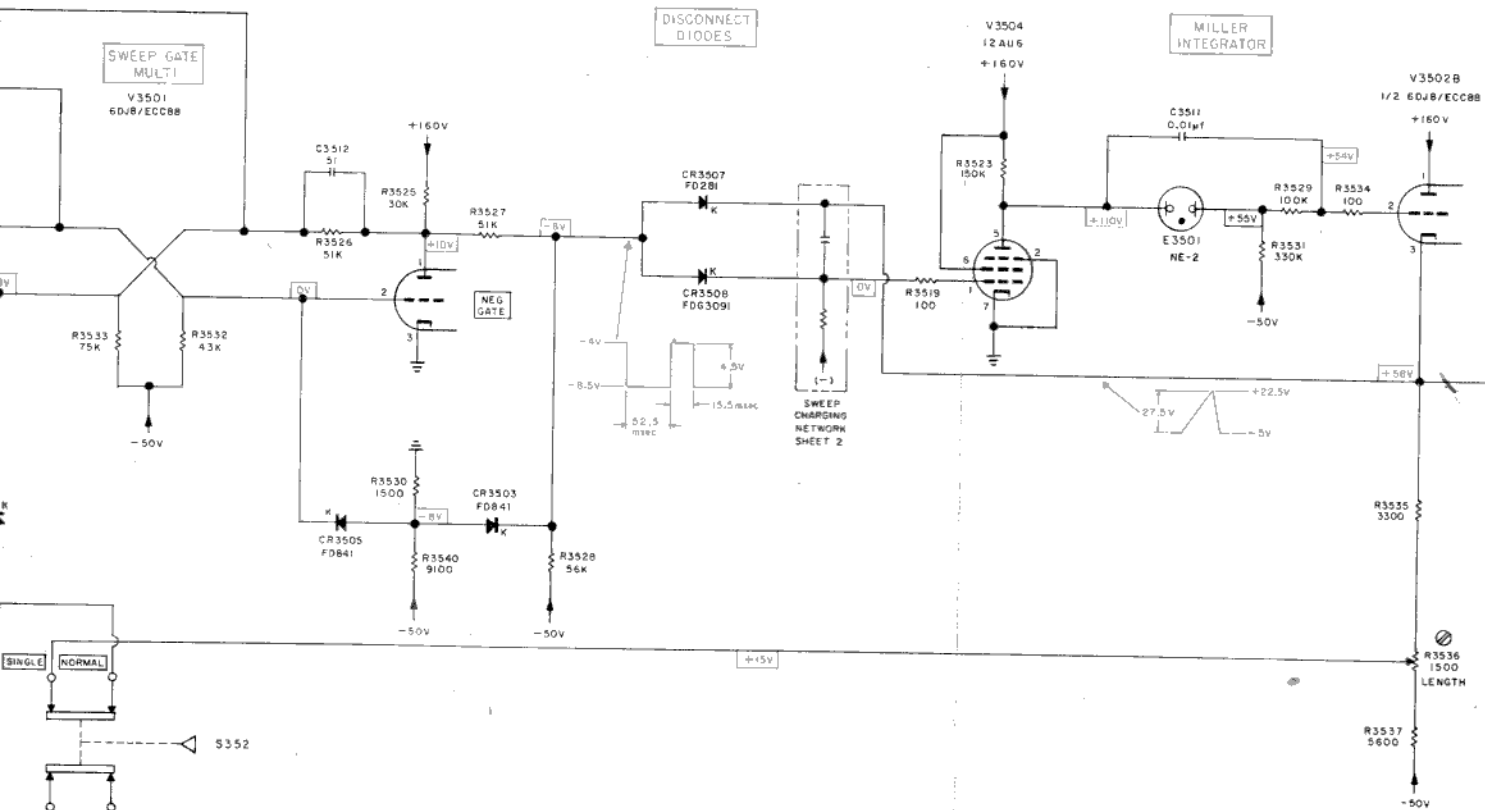
1. All voltage measurement with a VTVM using a probe.
2. Preset front panel contro

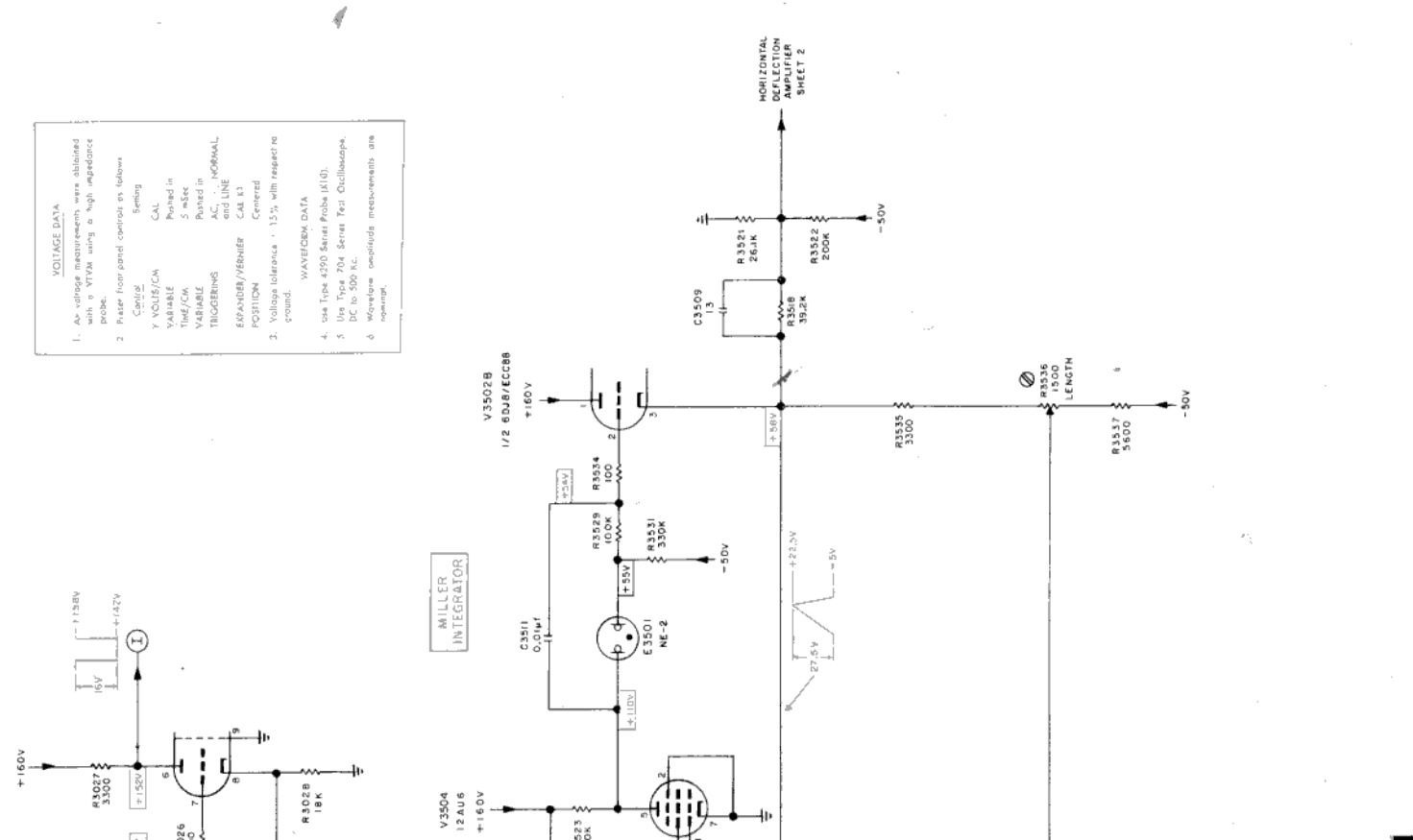
Control	
Y VOLTS/CM	C
VARIABLE	A
TIME/CM	S
VARIABLE	A
TRIGGERING	A
EXPANDER/VERNIER	C
POSITION	C

3. Voltage tolerance ± 1 ground.

WAVEFORM D

4. Use Type 4290 Series Pr
5. Use Type 704 Series T DC to 500 Kc.
6. Waveform amplitude m nominal




VOLTAGE DATA
1. As voltage measurements were obtained with a VTVM using a high impedance probe.
2. Front panel controls as follows
Control Setting
Y VOLTS/CM CAL
VARIABLE Pushed in
TIME/CM 5 mSec
VARIABLE Pushed in
TRIGGERING AC, ∞, NORMAL and LINE
EXPANDER/VERNIER CAL K3
POSITION Centered
3. Voltage tolerance ± 15% with respect to ground.
WAVEFORM DATA
4. Use Type 4290 Series Probe (X10).
5. Use Type 704 Series Test Oscilloscope DC to 500 Kc.
6. Waveform amplitude measurements are nominal.
HORIZONTAL DEFLECTION AMPLIFIER SHEET 2
V3502B
1/2 6DJ8/ECC88
+160V
R3521 26.1K
R3522 200K
-50V
C3509 13
R3508 39.2K
R3536 1500 LENGTH
R3535 3300
R3537 5600
R3534 100
R3529 100K
R3531 330K
+55V
+56V
C3511 0.01µf
E3501 NE-2
+110V
MILLER INTEGRATOR
+22.5V
-5V
27.5V
V3504
12AU6
+160V
R3525 100K
R3527 3300
+138V
+147V
16V
+150V
R3526 10
R3528 18K